Reaching Out

Canada, International Science and Technology, and the Knowledge-based Economy

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Report of the Expert Panel on Canada's
Role in International Science and Technology

Presented to :
The Prime Minister's Advisory Council on Science and Technology

Advisory Council on Science and Technology
Conseil consultatif des sciences et de la technologie

Expert Panel on Canada's Role in International S&T
Groupe d'experts sur le rôle du Canada dans les activités internationales de S-T

23 June 2000

Dr. Gilles G. Cloutier
Deputy Chair
Advisory Council on Science and Technology
235 Queen Street, West Tower, Room 824D
Ottawa, Ontario
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Dear Dr. Cloutier:

It is our pleasure to submit to you our report entitled *Reaching Out: Canada, International Science and Technology, and the Knowledge-based Economy.* The report contains our unanimous conclusions and recommendations.

We wish to thank the Advisory Council on Science and Technology for the confidence it has placed in us. We believe that our recommendations contained herein will maximize the social and economic benefits to Canada resulting from its involvement in international S&T. We also believe that our recommendations will enhance Canada's status on the international S&T scene — from that of a relatively minor player in S&T interactions to that of an important and valued participant in the international S&T community — and help Canada to become a world leader in the areas of S&T in which it is currently strong.

Yours sincerely,

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Chair's Message

The Expert Panel on Canada's Role in International Science and Technology was established in May 1999 by the Prime Minister's Advisory Council on Science and Technology (ACST). The Panel held its first meeting in November 1999, and has worked within a very tight schedule. It is a tribute to the commitment and expertise of my nine colleagues that this report has been completed in such a short time frame. I would be remiss if, on behalf of the Canadian members of the Panel, I did not express my most sincere appreciation for the exceptional commitment and contribution of Dr. Allan Bromley, our international representative and American colleague.

The report is based on extensive consultations with the academic, government and private sectors. A study commissioned by the Panel reported on the findings obtained through a large mail-out consultation with close to 400 key stakeholders, in addition to 30 in-depth telephone interviews with senior officials. An invitation to submit views through the Web resulted in 15 additional submissions. More than 20 key officials from a wide range of international science and technology (S&T) organizations and programs were invited to express their perception of Canada's role in international S&T. The Panel met with key representatives from various S&T and industry associations. It commissioned a study on the international strategies of a number of selected countries and met with Canadian S&T representatives posted abroad and foreign S&T representatives posted in Canada. Finally, close to 150 senior officials participated in the six regional workshops that the Panel organized across the country.

The consultation process and the presentations made to the Panel raised a number of important issues. The temptation was great to address many of them. However, the Panel was determined to limit its recommendations to one for each of the three questions included in its Terms of Reference. This has not been an easy task, but the Panel believes that it has addressed the most critical and urgent issues. The broad support received at the regional workshops for the report confirmed that the Panel's findings were appropriate and that the Panel's recommendations met the needs of the academic, government and private sectors.

In terms of its mandate and throughout its report, the Panel has interpreted the term "science" to include the social sciences. The Panel is fully aware of the importance of the social sciences in contributing to the economic well-being and improved quality of life of Canadians, and of the role of the social sciences in supporting the innovation process.

Canada, with 0.5 percent of the world's population, generates about 4 percent of the world's scientific knowledge. Although this reflects that Canada is a scientifically active country, it also demonstrates that Canada is highly dependent on the rest of the world for much of the scientific knowledge that it needs to maintain its enviable position. On the technology side, Canada imports 65 percent of its new technologies, the highest percentage among the G7 countries. These facts confirm the critical importance of international S&T for Canada, at a time when recent studies have shown that technical progress is the most important source of economic growth. The Panel is confident that the recommendations contained herein provide the framework and the tools for maximizing Canada's involvement in international S&T, to support Canada's advancement of knowledge, industrial innovation by Canadian firms, and improvement in the quality of life of Canadians.

René Simard
Chair,
ACST Expert Panel on Canada's Role in International Science and Technology

Acknowledgements

The Panel is very grateful to the many individuals who helped shape this report, by meeting with the Panel, participating in the initial mail and telephone consultation process, or providing detailed submissions.

We are also grateful to the many individuals who took the time to travel, review the draft Panel report and participate in the regional workshops. Their support and constructive comments were invaluable.

We are indebted to Mr. Peter Harder, Deputy Minister of Industry Canada; Mr. Kevin Lynch, Deputy Minister of Finance; Mr. Robert Wright, Deputy Minister of Foreign Affairs and International Trade; and Mr. Edward Goldenberg, Senior Policy Advisor in the Prime Minister's Office, for their time and their interest in the work of the Panel.

We wish to acknowledge the valuable contributions of Chummer Farina, ACST Executive Director, who provided sound advice, and Andrée Bichon who, as Panel Secretary, efficiently managed the various steps of the project and provided in-depth strategic guidance for the work of the Panel and the preparation of its report.

Finally, we wish to thank Doug Williams from KPMG for his contribution to the writing of the report, Britt White from the Panel Secretariat for her professional support to the Panel's activities and report, and Christine Claessen, also from the Panel Secretariat, for her superb administrative support.

Contents

EXECUTIVE SUMMARY i

1.0 INTRODUCTION 1

1.1 International Science and Technology and the Role of Government 1

1.2 The Expert Panel 2

2.0 THE LINK BETWEEN SCIENCE AND TECHNOLOGY AND ECONOMIC GROWTH 4

3.0 THE CONTEXT 8

3.1 Canada's International S&T Activities 8

3.2 The Canadian Policy Context 10

3.3 Policies of Other Countries 12

3.4 Benchmarking Canada 14

3.4.1 R&D Spending 14
3.4.2 Resources for International S&T Activities 15
3.4.3 Coordination of Government S&T Activities 16

4.0 SCIENCE 16

4.1 Current Activities 16

4.1.1 Research Collaboration and Research Training 16
4.1.2 Research Through Large-scale Facilities and International Programs 19
4.1.3 Research Related to International Scientific Issues 21
4.1.4 Research Related to International Economic Issues 22

4.2 Issues to be Addressed 23

4.2.1 Shortage of Resources for International Research Activities 23
4.2.2 Perception of Canada on the International S&T Scene 27
4.2.3 Lack of a Coordinating Mechanism 27

5.0 TECHNOLOGY 28

5.1 Current Activities 28

5.1.1 Activities to Acquire New Technologies and Technology Intelligence 28
5.1.2 International R&D Activities of Companies 29
5.1.3 International S&T Activities of Government Intended to Support the Innovation Process for Canadian Industry 30

5.2 Issues to be Addressed 32

5.2.1 Lack of Financial Resources of SMEs for International S&T 32
5.2.2 Difficulty of Obtaining Intelligence and Assistance Abroad 32
5.2.3 Other Issues 33

6.0 GOVERNMENT POLICIES 33

6.1 Current Activities 33

6.1.1 Support for Trade and Investment Policies 33
6.1.2 Support for Foreign Policy 35

6.2 Issues to be Addressed 37

6.2.1 Shortage of Resources for Policy Development 37
6.2.2 Lack of a Coordinating and Priority-setting Mechanism 37
6.2.3 Perception of Canada on the International S&T Scene 38
6.2.4 Leadership 38
6.2.5 Link Between International S&T and Foreign Policy 38

7.0 RECOMMENDATIONS 38

7.1 Vision 38

7.2 Recommendations 39

7.3 Additional Comments of the Panel 43

ANNEXES

A — Panel Work Plan 46

B — Panel Solicited Stakeholder Input 47

C — Inventory of Canada's Federal Participation and Investment in International S&T 57

D — Canada's Central Sources of Funding for International S&T Projects and International Researcher Exchanges in S&T 80

E — Central Sources of Funding for International S&T Projects and International Researcher Exchanges in S&T in Selected Countries: Some Examples 87

F — List of Acronyms and Abbreviations 100

EXECUTIVE SUMMARY

In today's globalized, knowledge-based economy, science and technology (S&T) are key determinants of wealth creation and improvements in the quality of life. Competitive advantage among countries is primarily determined by the extent to which a country can develop, obtain, and skilfully apply scientific and technological information. Knowledge and new technologies arising through scientific advances are the basis of technological innovation which in turn is the primary driver of wealth creation and economic growth.

International S&T is necessary in order to obtain the scientific and technological information Canada needs to be successful in maintaining and improving our standard of living and quality of life. Without effective international S&T activities

- the quality of the scientific knowledge we produce through our own research activities would decline, due to our inability to access the world's best facilities, equipment and talent;
- we would have limited and late access to the scientific knowledge produced by researchers in other countries;
- our companies would be unable to acquire the technological information they need to remain competitive; and
- many of our government policy decisions would be based on inadequate information.

The government of Canada has moved quickly in recent years to create an effective platform of investment in university research in S&T. The Canada Foundation for Innovation, the Canada Research Chairs, the Networks of Centres of Excellence and the programs of the federal research granting councils are evidence of this. However, gaps remain. These programs do not currently have the mandate or resources to enhance Canada's participation in international S&T. Moreover, these investments in university research have not been matched by investments in our government research labs or in mechanisms to assist Canadian small- and medium-sized enterprises (SMEs) in conducting the international S&T activities that are critical for their survival.

Canada currently places low priority on its participation in international S&T, as expressed through the lack of a coherent policy framework, the lack of an efficient mechanism for coordination and the lack of appropriate investment. And it shows. Canada is currently viewed as a poor international partner in S&T; it has not developed critical mass in international S&T networks; and it is missing out on new opportunities to dramatically advance its scientific capacities, knowledge, talent and technology. The Panel feels very strongly that it is time to take the next step in building on the important federal S&T investments made recently, by creating an effective environment to enhance Canada's participation in international S&T.

Speed wins in the global knowledge society. Advances in virtually all fields are taking place at breakneck speed. Innovative ideas and technologies originate with individuals, research networks, centres of excellence and companies located around the world. For Canada to take full advantage of this knowledge, talent and technology in a timely fashion, it is imperative and urgent that Canadian researchers, universities and companies become integral partners in the international effort in S&T.

Effective participation requires a critical mass of excellent scientists and science, together with involvement in innovation clusters linking technology, scientists, universities, investment, industry and communities.

Investment is required. Unlike many other countries, Canada lacks program instruments and an organizational structure to support scientists in international research collaboration and in using research facilities outside of Canada. There are currently more than 500 bilateral or multilateral S&T agreements between Canadian federal and provincial government departments and organizations in other countries. However, the government has not kept pace with the creation of a policy framework, coordination, and the investment of resources necessary to allow Canadians to be full and equal collaborators in such ventures. S&T agreements without plans, targeted goals, and necessary investments and evaluation are detrimental to our credibility with our partners and hurt Canada's global reputation.

Canada also lacks program instruments to support Canadian industry in accessing and assessing foreign technology and in developing partnerships with international counterparts.

It is now well established, as well as documented in this report, that the benefits of international research and collaboration far outweigh the costs. Canada is coming from behind, and the federal government and its partners can no longer ignore or delay the development of a comprehensive strategic plan to enhance Canada's participation in international S&T.

The following are some of the Panel's specific findings that form the basis of its recommendations.

With respect to scientific research:

- There is a critical shortage of resources for international S&T activities.
- There is a perception that Canada's credibility as an important, scientifically active country and Canada's reputation as a reliable partner have been seriously eroded.

With respect to the international S&T activities of Canadian industry:

- Large companies are carrying out international S&T activities on a regular basis. However, SMEs have very limited financial resources for international S&T activities, and there are few mechanisms available to assist them.
- SMEs currently have major difficulties accessing and assessing international S&T intelligence, and they need assistance in accessing foreign technologies and in developing international partnerships.

With respect to government policy:

- There is no effective mechanism for the coordination of the international S&T activities of government departments and agencies. A better mechanism is critically needed for developing priorities and for identifying ways to maximize the government's return on its investment in international S&T.
- There is also a need for more effective monitoring of and response to developments on the international S&T scene.

Vision

The Panel's vision is that, over the next decade, Canada's status in international S&T will change: from that of a relatively minor player in S&T interactions with other countries to that of an important and valued participant in the international S&T community, and a world leader in those areas of S&T in which Canada is strong.

Canada's image must be changed to that of a knowledge-based economy and one where S&T adds value to natural resources and other sectors. The following factors are part of this image change:

- Our scientific research community must become known for its research leadership and not just for the competence of individual researchers.
- Our firms must continue to be among the most innovative in the world.
- Our government policies must be fully informed by the latest S&T knowledge.

In order to accomplish this, Canada must become a champion and a model of international S&T collaboration. Canada must develop programs and policies that set an example to the world and that take maximum possible advantage of international S&T opportunities in a timely fashion, in support of advances in scientific research, industrial innovation by Canadian firms and improvements in the quality of life for Canadians.

Recommendation 1: Science

The 1996 federal S&T strategy states that international activities should support domestic needs and that the various government departments and agencies are responsible for their international activities.

Within this strategy, the Panel recommends that the federal government create a special fund to encourage the scientific community to foster international cooperation. This fund would be accessible to the academic, government and private sectors as a contribution of limited duration to projects and initiatives. The fund is not intended to replace core funding in government departments and agencies.

The fund should provide additional support, when needed and on a competitive basis, for the following:

- international partnerships and collaborative research, including multi-sector partnerships;
- Canada's participation in international programs;
- Canada's access to international facilities;
- Canada's participation in international S&T organizations; and
- Canadian participation in activities under bilateral and multilateral government-to-governmentS&T agreements.

The allocation of funds should be based on excellence as determined by peer review (where applicable), strategic needs as identified by the Executive Committee proposed in Recommendation 3 and impact on innovation, and it should give full consideration to the provincial international S&T strategies.

The fund should be managed by a non-departmental federal organization and evaluated on a five-year cycle.

The Panel believes that the fund will enhance Canadian participation in key international endeavours, ensure its continuity when appropriate and, as a result, restore the visibility and credibility of Canada on the international S&T scene.

Recommendation 2: Technology

Given that Canadian SMEs are the fastest-growing part of the Canadian economy in terms of job creation, and that SMEs are largely dependent on international new technology business development, the Panel recommends that a new mandate with additional resources be given to the Industrial Research Assistance Program of the National Research Council Canada (IRAP/NRC) to support the international S&T endeavours of Canadian SMEs.

Under this new mandate, in cooperation with DFAIT and other partners (as appropriate), and in accordance with the guidance of the Executive Committee proposed in Recommendation 3, IRAP/NRC should undertake the following:

- gather and analyse strategic technology intelligence and funding opportunities on the international scene;
- access and assess technologies developed abroad, through visits, technology missions, networking, and partnering events; and

- through these activities, support SMEs in setting up international technology-based ventures to enhance their development; this support would be provided for the identification of potential partners, negotiation of intellectual property rights, and preparation of submissions for accessing international funding programs and feasibility studies, as needed, for the benefit of the Canadian economy.

The Panel believes that this new mandate should enhance the development of Canadian SMEs, improve their market access, increase their competitiveness in the economy and provide a focal point for the international S&T endeavours of SMEs. The Panel believes that IRAP/NRC is the pre-eminent organization for such an activity, as its network is highly decentralized, but connected nationally and internationally.

Recommendation 3: Government Policy

The Panel believes that S&T is critical to the development of a knowledge-based society, and it recommends that S&T be included in Canada's foreign policy.

In addition, the Panel recommends the following:

- **The responsibility for international S&T should be assumed by an executive committee to be chaired jointly by DFAIT's Deputy Minister, International Trade and Industry Canada's Deputy Minister.**

- **The membership of this executive committee should include major S&T stakeholders and the heads of the organizations that will manage the new funds for international activities.**

- **This committee should be responsible for**
    - **defining Canada's international S&T policy;**
    - **coordinating Canadian decentralized international S&T activities, i.e., it should**
        1. **identify areas of overlap and duplication, and assist in their mitigation;**
        2. **identify gaps in essential requirements, and help ensure they are bridged;**
        3. **note activities offering potential synergy, and foster cooperation;**
        4. **provide oversight to the organizations managing the new funds; and**
        5. **assess the activities funded on a regular basis in order to determine their continued relevance; and prepare and maintain an inventory of international activities supported by the government and report on those activities on an annual basis.**

- **In countries identified as being key for the implementation of the international S&T policy, DFAIT heads of mission should be specifically charged in their mandate letters with personal responsibility for the delivery of the S&T program, and their performance should be assessed through the annual appraisal process.**

The Panel also believes it is essential that the needs of Canada's academic, government and private sectors to constantly monitor and respond to the rapid developments on the international S&T scene be addressed in an increasingly relevant and timely fashion. As a result, the Panel recommends that the executive committee also be responsible for defining the number, the selection criteria, tasking, geographic location, and re-allocation of DFAIT's S&T counsellors and technology development officers. The Panel recommends that these positions be allocated through a well-advertised competitive process open to the academic, government and private sectors, and that a thorough assessment be conducted at the end of these postings.

1.0 INTRODUCTION

1.1 International Science and Technology and the Role of Government

Canada is committed to maintaining a high standard of living and quality of life for Canadians. In today's globalized, knowledge-based economy, the traditional natural resources in the ground are no longer key to assuring countries the competitive advantage needed to succeed. Rather, as amply demonstrated by countries with limited natural resources, competitive advantages are created by entrepreneurial people who can successfully use a synergistic blend of knowledge-based resources in a timely fashion. Increasingly, science and technology (S&T) are recognized as being key elements of those competitive advantages.

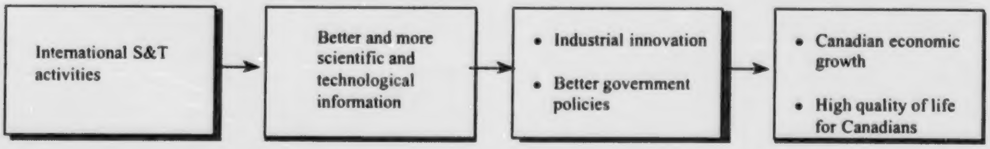
Globalization does not apply only to industry and trade, but to all human endeavours. Problems associated with health, sustainable development, the environment and so on can no longer be confined within the boundaries of any country. Our government policy increasingly relies on sound S&T knowledge. International S&T is playing an increasingly important role in a wide range of both domestic and foreign policies. Addressing those issues and finding innovative solutions depend on the cooperation and efforts of the world's best minds and resources.

Canada's Science and Technology Policy is based on three fundamental objectives: to advance knowledge, to create wealth through jobs and growth, and to enhance the quality of life. Although the 1996 federal S&T strategy stipulates a clear international angle in its operating principles, it is primarily domestic in focus as international activities are seen as one of the means of achieving the national objectives.

Canada, with only one half of one percent of the world's population, generates about 4 percent of the world's scientific knowledge. Many Canadian scientists and engineers are recognized as being among the best in the world in their field. Although this reflects that Canada is a scientifically active country, in the same league as many so-called "advanced" countries, it also demonstrates that Canada is highly dependent on the rest of the world for much of the scientific knowledge that we need to maintain our enviable position. As a result, it is critical that our researchers be able to work on the most important problems, collaborate with the best people, and use the best and latest facilities and equipment. However, in recent years, resources devoted to international endeavours have been severely reduced.

Research and development (R&D) are key to the innovation process — not only industrial innovation that leads to wealth creation, but also innovation that leads to improvements in the quality of life. Timely scientific and technological intelligence from around the world and international linkages are essential elements of a successful R&D infrastructure. In the absence of international S&T interactions, our companies would be unable to acquire the technological information they need to remain competitive. At present, a full two-thirds of new Canadian technologies are imported from other countries.

These points are illustrated in the following chart:


International S&T activities
Better and more scientific and technological information
• Industrial innovation
• Better government policies
• Canadian economic growth
• High quality of life for Canadians

In summary, international S&T activities are necessary for advancing knowledge, creating wealth and improving quality of life.

- Our researchers need to collaborate and exchange scientific information with researchers in other countries in order to stay abreast of the latest scientific developments. They also need to have access to the best equipment, facilities, and talent wherever they are located, and they need to be able to participate in large-scale research projects that are beyond the capability of Canada to finance alone.

- Our companies need to be able to acquire information regarding new technologies from around the world — both for the purposes of competitive intelligence and for their own use in developing new products and services. They also need to be able to carry out R&D activities themselves with the best possible partners, wherever they are located.

- Our governments need to participate in and contribute to international scientific forums in order to make good decisions regarding international science-based issues (e.g. issues related to environment or genomics) and to develop international scientific protocols, codes and standards.

Governments in all advanced industrialized countries are active in supporting and facilitating international S&T activities. Governments provide funding for international S&T activities that are in the country's interest and that would not otherwise be undertaken. Governments also help to provide access to international S&T knowledge and resources and provide much of the supporting infrastructure to enable scientists to participate in leading-edge R&D.

This support is generally considered to be an opportunity and an obligation for government. If a government did not adequately support international S&T activities, the country would not be able to take sufficient advantage of international S&T knowledge. As a result, it would probably not be able to maintain its standard of living.

There is a perception that, over the past decade, the Canadian government's support for international S&T has been inadequate. The research conducted by the Panel and the presentations made to the Panel have made it clear that this is a major issue for Canada.

With respect to terminology, the term "science and technology" or "S&T" has been used throughout this report, for the sake of simplicity. However, the Panel would like to emphasize that, although science and technology are often associated, they are different in nature. Scientific activities are generally longer-term and are focussed primarily on the advancement of knowledge. Technology, on the other hand, refers primarily to the near-term application of the results of science and engineering research to the development of new products and processes. The difference is perhaps best summed up in the following:

> "Science studies what is. Technology creates what never has been."[1]

There is, of course, an overlap and a synergy that exists between science and technology — each provides information to and derives information from the other.

1.2 The Expert Panel

In May 1999, the Prime Minister's Advisory Council on Science and Technology (ACST) created an Expert Panel to examine Canada's role in international S&T, particularly the adequacy of government support and policies for international S&T. The Panel consists of 10 eminent members, nine Canadians and one American *(see "Members of the Expert Panel" at the beginning of this report).*

The Panel was asked to identify ways to best respond to the needs of universities, industry and government, and to address the following three broad questions.

1. *What are the best mechanisms with which to identify, prioritize and address Canadian researchers' needs to participate in international science opportunities?* This question deals with how the government can best support the international activities of Canada's **scientific research community** in universities, academic research institutes, government and private sector labs.

2. *What is the role of government in addressing and overcoming barriers to Canadian firms accessing international technology? If there is a role, what are the best mechanisms to identify, prioritize and address firms' needs for international S&T intelligence?* This question deals with how to best support the international S&T activities of **Canadian industry**.

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[1] Quote from Dr. Theodore von Karman (1881–1963), one of the world's foremost aerodynamicists and scientists, who is widely recognized as the father of modern aerospace science.

3. *Canada's international S&T policies need to be domestically driven and effectively linked to the government's agenda in trade and investment. What mechanisms would best create these linkages and enhance Canada's international image as a leading innovative nation?* This question deals with the extent to which our international S&T policies and support mechanisms are effectively linked with other **government policies**, such as policies related to trade, investment, international cooperation, and science and technology.

The work of the Expert Panel was conducted over the period from November 1999 to June 2000. The following were the primary activities carried out by the Panel *(see Panel Work Plan in Annex A)*:

- the review of information contained in (more than 20) briefs and (more than 30) presentations to the Panel from government, academic and industry representatives *(see Panel Solicited Stakeholder Input in Annex B)*;

- consultations with some 400 key stakeholders representing the three sectors (government, academic and industry), as well as in-depth interviews with selected stakeholders (10 from each sector), to obtain stakeholders' views regarding Canada's role in international S&T;[2]

- consultations at large through the Internet (some 15 briefs received);

- informal consultations by the Chair with key senior officials *(see Panel Solicited Stakeholder Input in Annex B)*;

- input solicited from 20 Canadians holding executive positions in international organizations as well as foreign heads of international organizations of which Canada is a member (some 15 letters received);

- a review of the policies and activities of other countries regarding international S&T;[3]

- consultations with Canadian science and technology counsellors (STCs) and technology development officers (TDOs), as well as S&T counsellors of selected foreign countries posted in Ottawa;

- six regional workshops (in Halifax, Ottawa, Montréal, Toronto, Calgary and Vancouver) to obtain the views of selected key stakeholders regarding the draft Panel report *(see Panel Solicited Stakeholder Input in Annex B)*;

The Panel would like to emphasize that, in terms of its mandate and throughout this report, the term "science" has been interpreted to include the social sciences. The Panel is fully aware of the importance of the social sciences in contributing to economic well-being and improved quality of life and, in particular, in supporting the innovation process. A recent report prepared by the Science Policy Research Unit of the University of Sussex in the United Kingdom stated the following:

> Few problems can be solved by technical approaches alone — technical decisions involve social choices as well. Environmental problems, health care solutions, and innovation within firms can all gain from research on the social aspects of technical change.... The social sciences have provided the basis for such public goods as national statistics, censuses, and large parts of the toolbox of the modern management of economies, all of which contribute in fundamental ways to the innovation process. Indeed, the entire way in which society knows about itself is inextricably linked to developments in the social sciences.[4]

The Panel also notes the Declaration of the World Conference on Science, which was jointly organized by the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the International Council for Science (ICSU) and held in 1999 in Budapest, Hungary. The Declaration calls for breaking down traditional barriers between the natural and the social sciences and adopting interdisciplinarityas a common practice.[5] It was endorsed by more than 100 countries, including Canada. The Canadian delegation played a key role in the drafting of the Declaration. The Panel strongly supports the directions taken by the Declaration, in particular as it relates to the integration of natural and social sciences.

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[2] The Impact Group, "Canada's Role in International Science and Technology: Consultations for the Expert Panel of the Prime Minister's Advisory Council on Science and Technology," May 2000.

[3] Roger Voyer, *International S&T Strategies: An International Comparison*, March 2000.

[4] Science Policy Research Unit, *Talent, Not Technology: Publicly Funded Research and Innovation in the UK*, (University of Sussex, May 2000).

2.0 THE LINK BETWEEN SCIENCE AND TECHNOLOGY AND ECONOMIC GROWTH

This section expands on the assertion in section 1.1 that S&T are key determinants of wealth creation. The purpose of this discussion is to help readers understand why it is a good investment for Canada to provide an adequate degree of support for international S&T.

The Canadian economist Richard Lipsey points out that, while advances in S&T alone are not sufficient to produce economic growth, they are critical inputs to economic growth, and can lead to new products, new materials, new ways of organizing activities, new supporting infrastructure, new industrial concentration and location, and entirely new and different jobs.[6]

The link between S&T and economic growth is innovation — the process by which new or improved products and processes are developed and introduced into the marketplace. Innovation is carried out by firms, interacting with the other players in a country's "innovation system" — institutions such as universities and research centres, government departments, educational and training institutions, financial institutions, networks that facilitate the exchange of S&T information, and so on. Innovation can involve the development of totally new products and processes based on dramatic new scientific discoveries, such as the creation of a new drug based on recent discoveries in biotechnology; or it can involve improvements to existing products and services over a period of time. However, if a firm is unable to innovate, for example, because it lacks access to the necessary new technologies (from an inability to develop the technologies itself, a lack of information about technologies developed elsewhere, or for other reasons), then the firm's competitive position will be affected, and its performance will deteriorate.

The basis of innovation is new technical knowledge. Robert Solow was awarded the 1987 Nobel Prize in economics for his work in developing a modern theory of economic growth, which is based on recognizing the importance of technological innovation and the underlying knowledge base. Solow concluded that most of the increase in output per capita in the United States over the period 1909–49 was attributable to technological change.

The finding that technical progress is the most important source of economic growth has been confirmed by more recent studies. For example, Boskin and Lau studied the relative contributions of capital, labour and technical progress to economic growth in five countries over the period 1948–85. They concluded that "over the period under study, technical progress is by far the most important source of economic growth, accounting for half or more (three quarters for the European countries)…."[7] This finding is summarized in Figure 1.

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[5] UNESCO, *Science for the Twenty-First Century: A New Commitment, Declaration on Science and the Use of Scientific Knowledge*, (Paris: UNESCO, July 1999), paragraphs 6(d) and 31.

[6] Richard Lipsey, *Globalization, Technological Change and Economic Growth*, Annual Sir Charles Carter Lecture, Report No. 103, July 1993, p. 6.

[7] Michael J. Boskin and Lawrence J. Lau, "Capital, Technology, and Economic Growth," *Technology and the Wealth of Nations*, Nathan Rosenberg et al., eds., (Stanford University Press, 1992), p. 47.

Figure 1: Relative Contributions of the Sources of Growth

Country	Capital	Labour	Technical Progress
France	28	-4	76
West Germany	32	-10	78
Japan	40	5	55
United Kingdom	32	-5	73
United States	24	27	49

Source: Michael J. Boskin and Lawrence J. Lau, *"Capital, Technology, and Economic Growth," Technology and the Wealth of Nations*, Nathan Rosenberg et al., eds., 1992

Note: The figure indicates the percentage of economic growth during the period under study that is due to each factor. For example, if economic growth (increased output) in France during the period was $100 billion, $28 billion was due to changes in capital inputs, -$4 billion was due to changes in labour inputs, and $76 billion was due to technical progress.

Economists currently treat *knowledge leading to technical progress* as a type of capital, which should be included with "real" capital in attempts to understand or predict economic growth. In today's developed economies, competitive advantage is determined more by knowledge and ideas, and less by raw natural resources and capital than has been the case in the past. Canada's future prosperity depends on our ability to develop and exploit new technical knowledge. This is true not only for "high-tech" sectors, but also for traditional industries.

Conducting scientific R&D is a major contributor to innovation and economic growth. A number of econometric studies carried out since the 1970s have concluded that the social rate of return on investment in R&D is between 50 percent and 100 percent. The recent findings have been summarized by Edwin Mansfield as follows:

> The first attempt to measure the social and private returns from investments in industrial innovations was a study conducted by myself and others, the results of which were published in 1977. That paper...indicated that the median social rate of return from the investment in our sample of innovations was 56 percent, a very high figure. This high rate of return was borne out in two subsequent studies commissioned by the National Science Foundation to replicate our study. Based on separate samples of 20 innovations each, the subsequent studies found the median social rate of return to be 70 percent and 99 percent respectively.[8]

Many people believe the reason R&D contributes to economic growth is because R&D produces new technical knowledge (research findings) which is then used in the development of new products and processes. Although a number of studies document these "direct impacts" of R&D and provide estimates of the resulting economic benefits,[9] it has become increasingly evident that much innovation does not occur in this linear way, and that many new products and processes are developed with little input from current research.[10]

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[8] Edwin Mansfield and Elizabeth Mansfield, eds., *The Economics of Technical Change*, (Edward Elgar Publishing Limited, 1993), p. xii.

[9] See The ARA Group, "Evaluation of the Networks of Centres of Excellence Program," December 1996.

[10] The classic theoretical paper on this topic is S.J. Kline, "Innovation is Not a Linear Process," *Research Management*, July-August, 1985. For empirical studies dealing with this topic, see W.F. Mueller, "The Origins of the Basic Inventions Underlying DuPont's Major Product and Process Innovations, 1920–1950," *The Rate and Direction of Inventive Activity*, R.R. Nelson, ed., (Princeton University Press, 1962) or G.W. Brock, *The U.S. Computer Industry*, (Cambridge, Mass.: Ballanger Publishers, 1975).

An example of the direct impact of R&D

In the 1930s, a research team at DuPont initiated a research project in linear superpolymers. This project began as an unrestricted foray into the unknown with no particular practical objective in view. But the research was in a new field of chemistry, and DuPont believed that any new chemical breakthrough would probably be of value to the company. In the course of the research, the research team obtained some superpolymers which at high temperatures became viscous fluids and observed that filaments could be obtained from these materials if a rod were dipped in the molten polymer and then withdrawn. At this discovery the focus of the research project shifted to these filaments. The result was the discovery of nylon, which was introduced by DuPont in 1938. The economic benefits of these research findings are in the billions of dollars.[11]

Why then is there a positive relationship between R&D and economic growth? The answer is that several different kinds of benefits arise from R&D. These are illustrated in Figure 2 on the following page.[12] The left side of the figure shows the "direct benefits" of R&D that are due to the application of research findings. The middle of the figure illustrates the benefits due to increased competencies developed by the researchers and others involved in the research process (i.e. from their increased knowledge and expertise). Benefits in this category result from the provision of scientific advice and assistance by the researchers and from their ability to access the worldwide knowledge base in their discipline. As documented in the previously referenced paper, these "competency benefits" can be very large — at least as large as the benefits resulting from the direct application of research findings.[13]

The right side of the figure illustrates the benefits that flow from the influence of the R&D process on the innovation system. The increased competencies of the researchers discussed above are part of this. In addition, there are other important ways in which conducting R&D strengthens the innovation system: the training of new researchers, the development of facilities, the development and strengthening of linkages between researchers and between organizations, and so on. There is a growing body of evidence that these "innovation system benefits" are the most important of all.[14]

A number of recent studies of Canadian government-supported research programs show that the direct benefits from the application of the program's research findings are more than sufficient to cover the cost of the program.[15] That is, R&D yields a positive rate of return even when the competency benefits and the innovation system benefits — which are generally larger than these direct benefits — are not included. In short, competitive world-class R&D are extremely good investments.

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[11] This example is summarized from the paper by Richard R. Nelson, "The Simple Economics of Basic Scientific Research," in Mansfield and Mansfield, eds., *The Economics of Technical Change*, 1993.

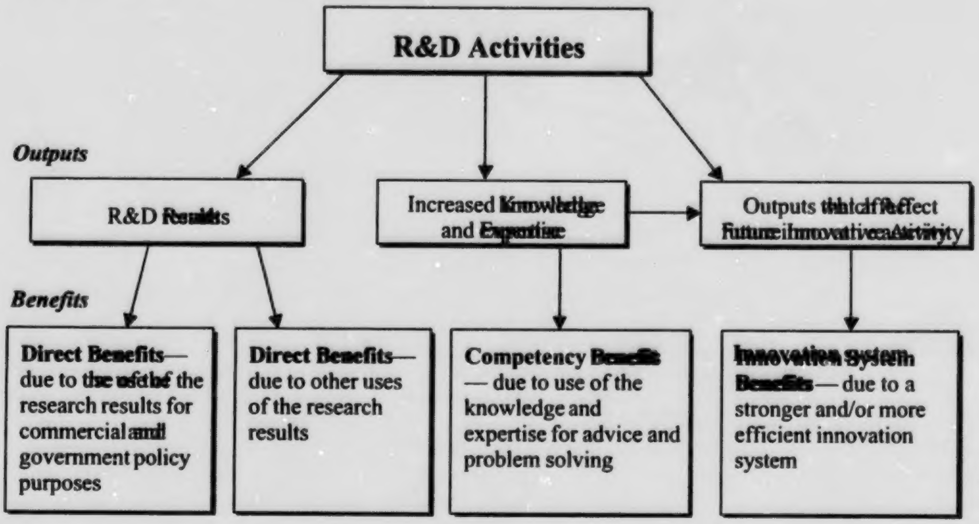
[12] This figure and the following discussion is adapted from the paper by Douglas Williams and Dennis Rank, "Measuring the Benefits of R&D: The Current State of the Art," *Research Evaluation*, April 1998.

[13] See also the paper by W.M. Cohen and D.A. Levinthal, "Innovation and Learning: The Two Faces of R&D," *The Economic Journal*, September 1989. This study shows that firms invest in R&D not just to generate research results for their own use, but often primarily to be able to utilize information that is available externally. Conducting R&D increases the firm's ability to identify, adopt and adapt knowledge from other sources because, by carrying out R&D, researchers increase their knowledge base and expertise.

[14] Science Policy Research Unit, *The Relationship Between Publicly Funded Basic Research and Economic Performance*, (University of Sussex, July 1996).

[15] The paper by Williams and Rank referenced previously at footnote 12 summarizes many of these studies.

Figure 2: Benefits of R&D Activities


R&D Activities
Outputs
R&D Results
Increased Knowledge and Expertise
Outputs that Affect Future Innovative Activity
Benefits
Direct Benefits— due to the use of the research results for commercial and government policy purposes
Direct Benefits— due to other uses of the research results
Competency Benefits — due to use of the knowledge and expertise for advice and problem solving
Innovation System Benefits — due to a stronger and/or more efficient innovation system

Examples of Benefits

- Development of a new product based on the results
- Development of a new production process based on the results

- Ultimate use of the results–or use of other research based on these results - for the development of new products, processes, etc.

- Development of government regulations based on advice from researchers
- Development of new products using the expertise gained in the research process

- Increased innovative activity as a result of linkages developed in the research process
- Development of a new product using equipment and facilities available as a result of the R&D effort

It is important to understand that the benefits resulting from carrying out R&D cannot be obtained simply by appropriating R&D findings produced by researchers in other countries. As discussed above, the benefits from the direct application of research findings are only a relatively small part of the overall benefits from R&D, and even these benefits often cannot be obtained unless a country is active in carrying out R&D itself. The most important findings are often not known (in a timely manner) except by those active in the same research field. Without being active in research, it is difficult to fully understand the findings and their implications. In short, "freeloading" is not free.

3.0 THE CONTEXT

3.1 Canada's International S&T Activities

Overview

The Canadian government and Canadian organizations and individuals are involved in a wide variety of international S&T activities. The following are the different types of activities and organizational arrangements.

- **Researcher-to-researcher collaborative projects.** Researchers in all types of organizations — universities, industry and government — are heavily involved in collaborating with other researchers, many of whom are in other countries.

- **Bilateral organization-to-organization agreements.** Many Canadian research organizations have umbrella-type collaborative agreements with research organizations in other countries. For example, the National Research Council Canada (NRC) has active collaborative agreements with the Centre national de la recherche scientifique (CNRS) in France and the British Council in the United Kingdom.

- **Bilateral government-to-government agreements.** Canada is a signatory to a number of bilateral agreements with other governments, such as the Canada–Germany S&T Cooperation Agreement.

- **Multilateral agreements.** Canada is also involved in multilateral agreements that involve joint participation in S&T activities with a number of countries. For example, Canada is a member of the Organisation for Economic Co-operation and Development (OECD) and participates extensively in the activities of the OECD's Directorate for Science, Technology and Industry.

- **Membership in international S&T organizations.** For example, Canada is a member of the International Council for Science (ICSU) and its bodies.

- **International programs.** Canada and Canadian researchers participate in a number of international S&T programs that provide funding for international collaborative research, such as the international Human Frontier Science Program.

- **International networks.** An example is the Canadian–European Research Initiative on Nanostructures (CERION), a network of research institutes and universities in the European Union (EU) and Canada to collaborate in the emerging area of nanotechnologies.

- **International facilities.** International facilities are generally large and expensive scientific research facilities that could not be funded by a single country alone. Examples are large telescope facilities and major subatomic physics laboratories. Researchers from many different countries carry out research at these facilities.

- **International technology acquisition and adaptation.** The Canadian government and Canadian companies are extensively involved in monitoring S&T developments around the world. Canadian companies are using S&T knowledge in the development of new and improved products and processes.

Scope of International Activities

A 1997 inventory of formal S&T arrangements between Canadian federal or provincial government departments and organizations in other countries lists *more than 500* such arrangements, including more than 60 multilateral arrangements.[16] The vast majority of these are Memorandums of Understanding (MOUs). Examples include the following:

- the Canada–Japan Science and Technology Agreement, a government-to-government S&T agreement;
- the MOU between the Natural Sciences and Engineering Research Council of Canada (NSERC) and the Royal Society of the United Kingdom, an agreement between a Canadian organization and a foreign counterpart;
- the MOU between Quebec and France Concerning Promotion of Technological Cooperation, an agreement involving a provincial government; and
- the MOU between the B.C. Science Council and the Philippines Department of Science and Technology on Scientific and Technological Cooperation, an agreement involving a provincial organization.

Federal Expenditures in International S&T

Among the science-based departments and agencies with earmarked expenditures for international activities, the following departments and agencies have the largest planned expenditures in international S&T in the 2000–01 fiscal year:

- the Canadian Space Agency — $17.3 million
- Health Canada — $16.7 million
- National Research Council Canada — $13.1 million

Current federal investment in major international programs, facilities and organizations directly related to the performance of S&T is in the order of **$69 million per year.** An inventory of Canada's federal participation and investment in international S&T is available in Annex C. The annex does not include the activities of the Canadian International Development Agency (CIDA) or the International Development Research Centre (IDRC). Both agencies are active in international S&T, but primarily in supporting capacity building in developing countries, not in the performance of S&T activities. The Panel recognizes the importance of capacity building, but did not consider this to be within the scope of its mandate *(see section 7.3).* Figure 3 on the following page shows the distribution by sector of the federal investment of $69 million per year in major international programs, facilities and organizations that are directly related to the performance of S&T.

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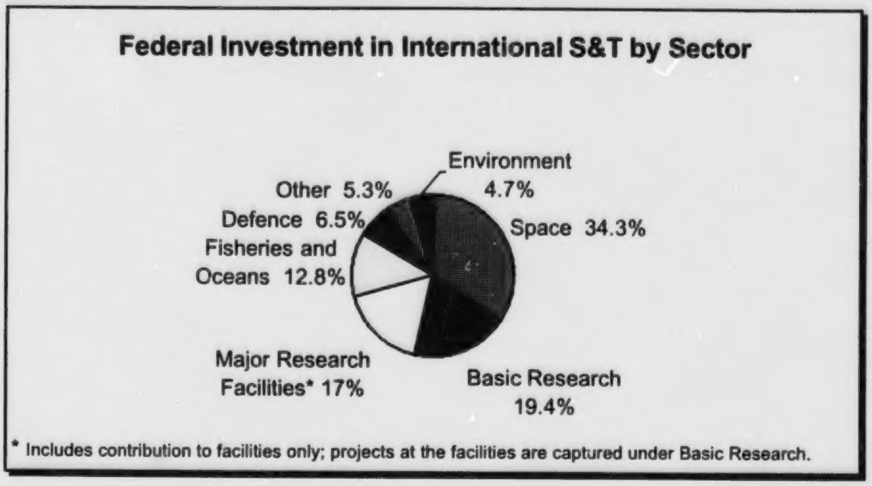
[16] Department of Foreign Affairs and International Trade, *Federal and Provincial Science and Technology Arrangements,* August 1997.

Figure 3



Federal Investment in International S&T by Sector

* Includes contribution to facilities only; projects at the facilities are captured under Basic Research.

3.2 The Canadian Policy Context

The governance and funding of S&T in the Canadian federal government is managed through a decentralized system. The government finances S&T through the programs of its science-based departments and agencies (SBDAs), which in turn manage their programs in accordance with their particular mandate and operational requirements.

R&D are important components of government S&T activities.[17] The total expenditure on R&D for the 1997–98 fiscal year by all sectors in Canada was $13.9 billion.[18] The federal government's portion of these expenditures was approximately $3.0 billion. This does not include the amount "spent" by the federal government in the form of foregone revenues due to the Scientific Research and Experimental Development (SR&ED) Tax Incentive Program, a program of tax incentives to support the costs of R&D conducted by industry. Provincial governments have a parallel departmental structure, and their share of total Canadian R&D expenditures in the 1997–98 fiscal year was approximately $0.7 billion.

The main federal government policy document dealing with S&T is the 1996 federal S&T strategy.[19] This strategy, which was prepared following extensive consultations, outlines a series of governance mechanisms, operating principles and priorities to guide federal S&T. Two points are especially important to note:

- Although the strategy specifies common principles and priorities for the SBDAs, it assumes the continuation of the current decentralized system.
- Although the strategy mentions international S&T, it focusses on domestic S&T activities; international S&T activities are seen primarily as part of the means of achieving domestic goals.

The strategy does require SBDAs to explicitly include international S&T activities within their departmental mandates. It states: "As an extension of their domestic mandates, federal departments and agencies will develop explicit plans to promote international S&T collaboration for the benefit of Canadian firms." To the best of the Panel's knowledge, only NRC has developed an explicit international strategy of this type.

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17. S&T = R&D + RSA, where RSA (related scientific activity) involves the collection, processing, collating and analysing of scientific data.

18. The data in this section are from the publication by Industry Canada, *Science and Technology Data — 1998*, (Industry Canada, January 1999).

19. Government of Canada, *Science and Technology for the New Century: A Federal Strategy*, (Ministry of Supply and Services Canada, 1996).

The strategy also commits the government to assisting Canadian firms with international S&T activities: "[The government will] improve Canada's innovative capacity by linking Canadians to domestic and international networks...."

The main policy responsibility for S&T in the federal government rests with Industry Canada. However, the main policy responsibility for international activities rests with the Department of Foreign Affairs and International Trade (DFAIT). ***No one department has exclusive responsibility for international S&T matters.*** This is in the context where, in recent years, government has made special efforts to create a synergy and a critical mass by involving jointly several agencies for reaching common objectives regarding complex, multi-faceted issues. Team Canada and Investment Partnerships Canada are recent examples of joint efforts to address such issues.

The S&T resources at DFAIT include an S&T unit, referred to as TBR, at DFAIT headquarters in Ottawa, and a number of S&T counsellors (STCs) and technology development officers (TDOs) posted in Canadian embassies abroad. In embassies where there is neither an STC nor a TDO, S&T matters are dealt with on an ad hoc basis by a commercial officer or a trade commissioner.

The headquarters unit is responsible for providing support to the SBDAs regarding their international activities, managing the STC and TDO networks, managing the funds for international S&T activities ($400 000), and managing the government-to-governmentbilateral S&T agreements.

There are five STCs, posted in London, Berlin, Brussels, Washington and Tokyo, and one space counsellor in Paris.[20] They are usually seconded from an SBDA for a three-year period, with a possibility of a one-year extension. Their main responsibilities are

- to identify key international S&T strategic and policy decisions of other governments that are important for Canadian decision making;
- to promote Canadian S&T capabilities abroad — in order to enhance Canada's international reputation and attractiveness as an S&T partner, as a place for foreign direct investment, and as a source of quality technology products and services; and
- to facilitate S&T partnering and, in cooperation with the TDOs, identify technology opportunities.

There are five TDOs: one posted in Paris, two in Berlin, one in Tokyo and one in Atlanta. They are locally hired. Their main responsibility is to assist Canadian firms with the acquisition of foreign technologies, technology partnering and technology intelligence.

This past decade has been a difficult one for the S&T program at DFAIT. The network of STCs and TDOs consisted of eight STCs and 12 TDOs in the early 1990s. In 1993, DFAIT announced the elimination of its S&T unit and the elimination of the STC/TDO network, but later rescinded its decision. In 1997, the department considered the possibility of eliminating the STC network. However, under pressure from the federal research councils, the department backed away from this. The STC/TDO network is currently half its former size. Furthermore, some of the presentations made to the Panel also expressed the opinion that the STCs and TDOs are spending large amounts of their time and resources on investment and trade activities, and correspondingly less on S&T issues.

At one point DFAIT also funded the Technology Inflow Program, a program that assists Canadian companies with their foreign visits. The department eliminated this program in 1993. Since that time, NRC's Industrial Research Assistance Program (IRAP) has been contributing $1 million per year from its own funds to keep the program going. Until the mid-1990s, the department also provided funding to support Canada–Japan S&T activities through the Canada–Japan S&T Fund.

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[20] The Science and Technology Counsellor in London is locally engaged.

DFAIT is currently undertaking a reorganization of its S&T program. The department's plans include the following:

- providing additional resources at headquarters to support the STC/TDO network;
- conducting an analysis of needs for the network, including identifying where new S&T counsellors would be needed;
- creating a full-fledged division with a single focus on S&T;
- maximizing available resources and infrastructures at headquarters and abroad by integrating technology development within the existing network of the Trade Commissioner Service;
- keeping the existing STCs as a distinct, core group of experts;
- providing skills upgrading to officers in the field; and
- taking steps to improve relevance and global consistency in delivering DFAIT's S&T services.

However, it remains to be seen how and when the plans would be implemented.

3.3 Policies of Other Countries

As part of its research, the Panel commissioned a review of the international S&T policies and strategies of selected countries and the mechanisms used to support these policies. The countries selected were Australia, France, Germany, Japan, Netherlands, Sweden, the United Kingdom and the United States. The study also included an overview of the S&T situation in the European Union.

All the countries reviewed are active in international S&T, and they view it as important for the reasons outlined previously in section 1.1. These countries (such as the United States, United Kingdom and Australia) have explicit international S&T goals, or implicit international S&T goals (as in the case of Germany, Netherlands, Japan and Sweden), or they have thematic priorities (in the case of France). There are three main types of mechanisms used to support these goals:

- the establishment of enabling bilateral and multilateral agreements;
- participation in international research activities; and
- the maintenance of information networks.

All the countries have an S&T counsellor network as a key element of their information collection mechanisms. As shown in Figure 4, Canada's S&T counsellor network is comparable in size with those of other countries, and its distribution is generally in keeping with that of other countries. However, as also shown in Figure 4, Canada does not have any S&T officers posted abroad in addition to the S&T counsellor network. It is worth noting that, in some countries, this number of S&T officers can be quite large.

Figure 4: Distribution of S&T Counsellors and other S&T Officers

Country	Number	North and South America	Europe	Asia	Other Officers
Australia	8	Washington	Berlin, London, Paris	Tokyo, Seoul, Jakarta, Kuala Lumpur	
France	8	Ottawa, Washington	Berlin, London, Rome, Oslo, Stockholm	Tokyo	Attachés in 29 OECD countries
Germany	17	Brasilia, Washington (3)	London, Paris, Tel Aviv, Kiev, Moscow (2), Brussels (3)	Jakarta, New Delhi, Beijing, Tokyo	
Japan	3	Washington	Stockholm, Vienna (International Atomic Energy Agency)		34 attachés in 14 countries
Netherlands	7	Washington, San Mateo (California)	Berlin, Paris, Rome	Singapore, Tokyo	
Sweden	5	Washington	Berlin, Paris, London	Tokyo	About 50 attachés in 9 posts
United Kingdom	5	Washington	Berlin, Paris, The Hague	Tokyo	Officers in 7 posts
United States	10	Buenos Aires, Mexico City, Ottawa	Brussels (North Atlantic Treaty Organization), Moscow, Paris, Paris (OECD)	Seoul, Tokyo, Vienna (United States Mission to the United Nations System Organizations in Vienna)	About 200 officers (full- or part-time) in 180 posts
European Union	4	Washington (2)	Tel Aviv	Tokyo	Part-time officers in 3 posts
Canada	6	Washington	London, Paris, Brussels (EU), Berlin	Tokyo	5 TDOs

Source: Roger Voyer, *International S&T Strategies: An International Comparison*, March 2000.

As noted previously, the study also documented the situation in the European Union. The primary objective of the European Union's R&D program is to support the integration of EU member states into a single European entity by extending, complementing and enhancing the research activities of the member states. Since 1984, the European Union's R&D activities have been strategically planned and coordinated within multi-year framework programs that set out the priority areas to be covered during the life of the program. The current Fifth Framework Program specifies the priorities for the European Union's R&D activities for the period 1998–2002, with a budget of approximately 15 billion euros, i.e., approximately C$21 billion.

Australia is one of the countries reviewed that has explicit international S&T goals, and the Panel observed that those goals seem to fit the realities of the Canadian situation. They are the following:

- to improve Australian access to global S&T;
- to improve the capacity of firms, particularly small- and medium-sized enterprises (SMEs), to exploit new technologies, including information and communications technologies;
- to build productive alliances between industry, science and technology;
- to facilitate a culture of innovation in Australian business;
- to contribute to the commercialization of R&D; and
- to contribute to the government's wider economic objectives and action agendas for specific industries.

For most of the countries reviewed, the responsibility for international S&T falls within one or more government departments. A different approach is used in Sweden, where responsibility for certain aspects of international S&T have been assigned to the Swedish Office of Science and Technology. This is an arm's-length foundation with a mandate to monitor international S&T through a network of S&T counsellors and technical attachés. It is directed by a board with representatives from government, industry and the Swedish Academy of Engineering Sciences. Seventy-five percent of its budget is from the government; the rest comes from fees for service.

Finally, the Panel wishes to note the increasing importance the United States is placing on S&T in its foreign affairs. In a speech delivered on February 20, 2000, U.S. Secretary of State Albright stressed the role that science, technology and health play in foreign affairs, and announced that she might consider the following:

- the appointment of a science adviser in the State Department;
- the establishment of a science directorate within the department;
- a review of the S&T counsellor positions and an upgrading of S&T expertise across the department; and
- the development of a policy statement on S&T.

These initiatives are in response to a major report recently completed by the U.S. National Research Council dealing with the importance of science, technology and health in foreign affairs.[21]

3.4 Benchmarking Canada

3.4.1 R&D Spending

As is well known, the amount of money spent on R&D (gross expenditures on R&D) in Canada is relatively low, the lowest amount of any of the G7 countries. Even when the amount of country R&D spending is normalized by country size — for example, R&D spending per capita, or R&D spending as a percentage of gross domestic product — Canada still ranks next to last among the G7 countries (only above Italy).[22] Figure 5 on the following page shows the trends in relative country R&D spending since the early 1980s.

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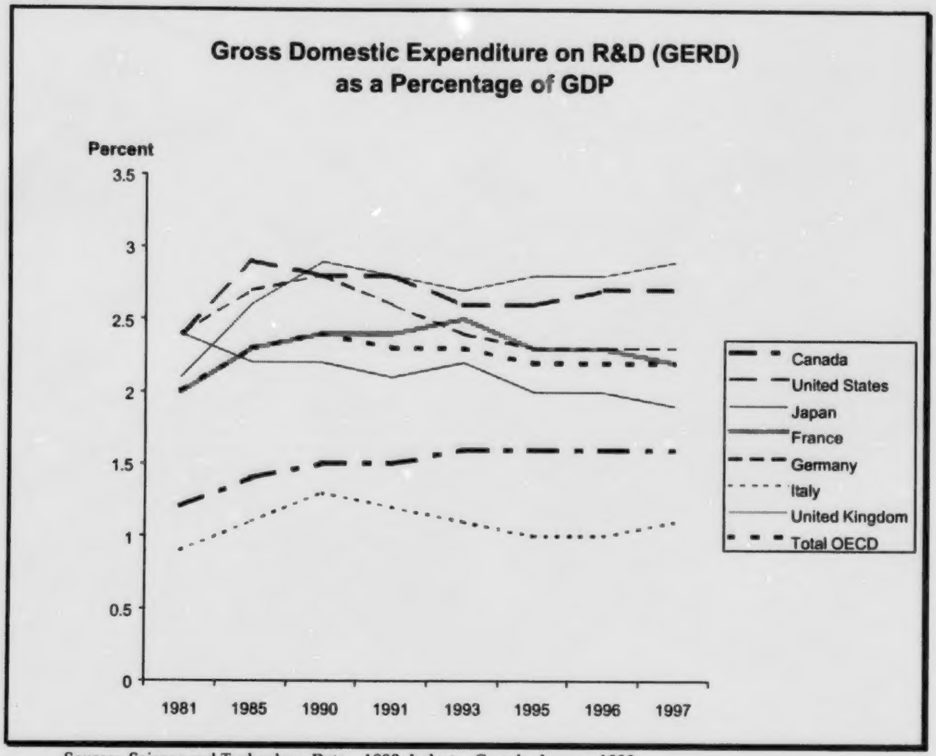
[21] U.S. National Research Council, *The Pervasive Role of Science, Technology, and Health in Foreign Policy: Imperatives for the Department of State*, 1999.

[22] See previous reference at footnote 18, Industry Canada, *S&T Data — 1998*.

Figure 5



Source: Science and Technology Data – 1998, Industry Canada, January 1999

3.4.2 Resources for International S&T Activities

Central Funding for International S&T Programs

With regard to central resources specifically devoted to international S&T activities, Canada lags behind most of the other countries reviewed in the international comparison study. For example, the German government has a central budget of approximately DM10 million to devote to expert visits and missions conducted under bilateral R&D agreements. Canada has no central funding devoted explicitly to bilateral agreements.

Canada's current central sources of federal and provincial funding for international S&T programs/projects and international researcher exchanges in S&T are described in Annex D. It is worth noting that these sources of funding are very limited and that none of them explicitly support activities undertaken under S&T bilateral or multilateral agreements. This is in sharp contrast with the extensive support given to those activities by other industrialized countries, as shown in Annex E.

S&T Resources Posted Abroad

As can be seen from Figure 4 in section 3.3, Canada also lags behind other countries with regard to S&T resources posted abroad. For example, in addition to its S&T counsellors, the United States has approximately one officer dealing with S&T matters in each of its 180 missions. Japan has 37 scientific attachés responsible for gathering and reporting on S&T information. France has a science attaché in every one of the 29 OECD countries. In addition to the counsellor network of the U.K. government, the British Council operates in 110 countries (including science programs in 76 countries), with a network of 23 designated science posts and 29 science-qualified managers. The German government has a staff of more than 100 people dealing with international S&T matters in addition to its counsellor network. Even in the smaller economies, the level of S&T resources posted abroad exceeds the Canadian level. Sweden, for example, has about 50 scientific attachés in nine posts.

3.4.3 Coordination of Government S&T Activities

One of the main respects in which Canada differs from the other countries studied is the decentralized structure of S&T, compounded by a lack of coordination of the S&T activities of federal SBDAs. Most of the other countries have structured their science policy more "horizontally" across government than Canada has done. This is achieved in a variety of ways, including the following:

- the existence of science advisers to the country's president or prime minister, or the existence of science ministers (who in both cases have real authority);
- the existence of a federal science budget that combines the science budgets of the various science-based departments and agencies and nationally funded research institutes (and therefore involves some degree of coordinated planning across these S&T organizations); and
- established mechanisms for central policy coordination of government S&T activities and organizations.

In addition, some countries have S&T foresight or Delphi exercises in which the various S&T organizations (SBDAs, research institutes and so on) participate and which provide overall direction for medium- and long-term planning in these organizations.

Canada's decentralized governance of S&T, lack of efficient coordination mechanisms, and lack of mechanisms for setting priorities in S&T are perceived as major difficulties for establishing a high level of S&T cooperation with our foreign partners that have a more centralized and coordinated approach to national S&T.

4.0 SCIENCE

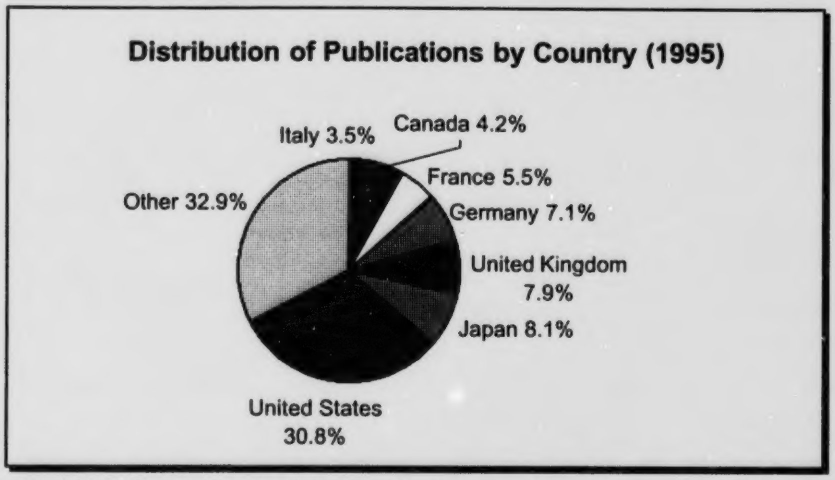
This section of the report deals with the international activities of Canada's scientific research community. The primary focus is on the research activities of universities and government laboratories. The international research activities of industry are discussed in section 5.

4.1 Current Activities

4.1.1 Research Collaboration and Research Training

Despite the fact that Canada has only 0.5 percent of the world's population, in 1995, Canada ranked sixth among the world's major producers of scientific knowledge. In that year, Canada produced 25 882 publications, or 4.2 percent of the world's scientific production *(see Figure 6)*. Although this is a remarkable accomplishment, it also shows Canada's dependence on knowledge produced abroad.

Figure 6



Source: Benoît Godin, Yves Gingras and Louis Davignon, *Knowledge Flows in Canada as Measured by Bibliometrics*, Observatoire des Sciences et des Technologies, October 1998

For decades, international collaboration has been a way of life in most scientific disciplines. A great deal of scientific research is carried out collaboratively. In order to conduct competitive world-class research, Canadian scientists need to be able to collaborate and exchange information with the world's best researchers in their field. They also need to have access to the best and latest equipment and facilities worldwide.

International research collaboration enables our research community to carry out better and higher-impact research. It is worth noting that international collaboration can have substantial payoffs: for example, of the 147 Nobel Prizes awarded in physics, chemistry, and medicine since 1950, 60 were given as joint international awards shared by researchers from different countries.[23]

Both Canadian university researchers and federal government scientists are very active internationally, and the level of international research collaboration is increasing. In 1980, 16 percent of Canada's scientific research publications were produced with foreign partners. By 1995, this percentage had increased to more than 30 percent. This figure is twice that found at the world level. As shown in Figure 7 on the following page, Canada is one of the highest-ranking countries in terms of foreign co-authorship of scientific publications.

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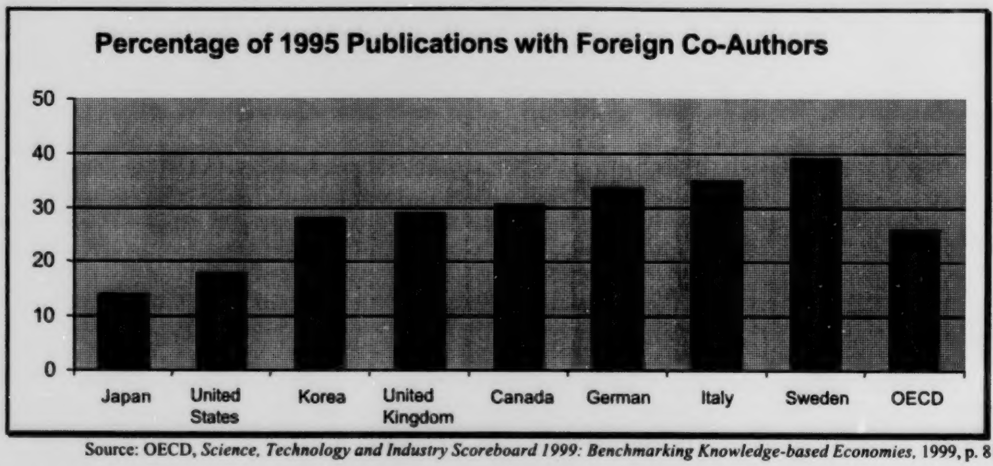
[23] See previous reference at footnote 21, U.S. National Research Council, *Science, Technology and Health in Foreign Policy*, p. 33.

Figure 7



Source: OECD, *Science, Technology and Industry Scoreboard 1999: Benchmarking Knowledge-based Economies*, 1999, p. 81.

The main types of activities and arrangements used by researchers to facilitate international collaboration are described in section 3.1. However, in most cases, collaboration is carried out informally on a researcher-to-researcher basis. As can be seen in Annex D, only one of the three university research granting councils (Natural Sciences and Engineering Research Council of Canada) has a budget explicitly devoted to international research collaboration, and that budget is very small: less than 0.7 percent of the council budget. However, researchers can use their "normal" research grants to support the costs of international collaboration.

There is no set of priorities to guide the allocation of resources for international scientific research. The priorities for the activities of university researchers are most commonly set by the researchers themselves, although granting agencies and peer reviewers have an influence. The priorities for government researchers are most commonly set by their individual departments and agencies.

Public policy benefits resulting from international research collaboration

In 1979, a collaboration was established between the University of Manitoba and the University of Nairobi. The collaboration was initially formed to focus on one research project (chancroid), but it was subsequently expanded to include a number of projects related to sexually transmitted diseases. In the early 1980s other scientists from around the world (from the United States, the United Kingdom, Belgium and the Netherlands) joined the collaboration. As a result of this research, these scientists were among the first to discover the presence of HIV in Africa, as well as important information regarding how the virus spreads, such as through breast feeding. The research team subsequently participated in the design of prevention programs in Africa (awareness campaigns targeted to vulnerable groups, community-based interventions, and so on) and in the training of health workers. From Canada's perspective, this knowledge enabled us to have made an early start with the design and implementation of effective awareness and public health programs in Canada.[24]

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[24] Health Canada and Canadian Public Health Association, "Canada's Contribution to HIV/AIDS Prevention: Progress Through Partnership", Summary Report of the Symposium held during the Fifth Canadian Conference on International Health, Hull, Quebec, 18 November 1998, p. 4

An example of ongoing international research collaboration in human sciences

The Metropolis project[25] is a huge international research project dealing with migration and the integration of ethnic and religious minorities in large cities around the world. It is intended to increase and coordinate research in the immigration and diversity fields and to provide useful information to government decision makers who deal with these issues. Canada's participation is being supported by a consortium of nine federal departments and agencies which provided $8 million in start-up core funds for the period 1996–2002. There are four Canadian Metropolis Centres of Excellence (in Montréal, Toronto, Edmonton and Vancouver), which collectively involve 15 universities and several hundred affiliated researchers. These Centres of Excellence are linked to the international research project, in which more than 20 countries are participating. Key international activities to date include the following:

- annual high-level conferences attended by ministers of national and state governments;
- comparative policy research seminars on such topics as transnational communities, the management of divided cities, and second-generation immigrants and education; and
- international comparative research projects on such topics as public attitudes toward immigration and ethnic diversity, barriers to employment, and other aspects of immigrant integration.

This project has already provided information that has made a significant contribution in Canada to the development of services to support immigration.

In addition to conducting research, our researchers are responsible for the training of future researchers; and training has an international dimension. There are many instances in which the best opportunities for training are in other countries. For example, the best-equipped labs may be overseas.

The number of Canadians studying abroad is still very low: fewer than 1 percent. It is interesting to note that, in contrast, the European Union has recently set a target of 10 percent as the desired number of students undertaking at least part of their formal studies abroad.[26] As stated in a presentation to the Panel: "Giving our future researchers international exposure early on has tremendous benefits: they start to think globally early and learn to develop the global skills and network of contacts that will ensure their success later on."

Attracting highly skilled researchers to Canada is also of critical importance. There is no doubt that Canada's perceived S&T image is a key element in this process.

There are currently relatively few programs allowing foreign students to study in Canada. The training of those students, especially those coming from developing countries, contributes to the enhancement of Canada's S&T image as a knowledge-based society and fosters future trade opportunities.

4.1.2 Research Through Large-scale Facilities and International Programs

Canadian researchers conduct research at a number of large-scale international facilities, such as telescopes and particle accelerators, and they participate in a number of large-scale international research programs. The following are the two main reasons for these international facilities and programs.

1. Size: The size and associated expense of the facilities or programs are so large that it would not be possible for any one country (except possibly the United States) to construct and operate the facility or carry out the program on its own.

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[25] See **http://www.canada.metropolis.net**

[26] Sally Brown, *Canadian Universities: Partners in Global Research*, (Association of Universities and Colleges of Canada, November 1999).

2. Efficiency: The pooling of resources, including cooperation in carrying out research and exchanging findings, enables better research findings to be obtained at lower cost than if the research were undertaken by one country on its own.

A listing of international facilities and programs in which Canadian researchers participate is contained in Annex C.

If Canadian researchers are to be competitive in many fields of research, they need to be able to participate fully in international facilities and programs. Without this participation, our researchers would often not be able to work at a competitive level on the most important problems in the field. World-class research in some fields, such as astronomy and particle physics, would be impossible.

The access of Canadian researchers is generally facilitated by the formal participation of the Canadian government as a partner in or contributor to the facility or program, or a related program or facility in the same research field. For example, the access of Canadian researchers to the European Organization for Nuclear Research (CERN), a particle accelerator in Geneva, is facilitated by the fact that Canada operates its own particle physics facility, the Tri-University Meson Facility (TRIUMF) accelerator in Vancouver, to which international researchers have access.

In cases in which Canada is not a contributor to the international research effort in the field, our researchers are sometimes accorded lower priority, and they could even be denied access. Until now, access to international facilities has been free of charge, because it was assumed that access was reciprocal. Discussions are now under way at a number of facilities to decide whether or not user fees or other ways of restricting access to non-reciprocating countries should be introduced.

As is the case for international research activities generally *(see section 4.1.1)*, there is no set of priorities to guide Canada's participation in international large-scale facilities and programs or the contributions of the Canadian government to these facilities and programs.

In addition to the research-related benefits of participation in large-scale facilities and programs, Canada's participation often provides opportunities for Canadian industry.

Canadian industrial benefits resulting from participation in international facilities

As a result of Canada's participation in the Canada–France–Hawaii telescope project through NRC, a Canadian steel fabrication company, AGRA Coast of Coquitlam, B.C., became involved in the construction of the telescope. During the bidding process, AGRA Coast consulted extensively with Canadian astronomy researchers. It won the contract, as well as several subsequent contracts related to the design, component fabrication and erection of the telescope. This work led AGRA Coast to develop a huge business in the fabrication of precision steel structures. It is currently the world leader in the design and construction of telescope structures, and the company has won more than $150 million worth of contracts in this area. In addition, the company has used this expertise in a number of non-astronomy areas (such as satellite tracking systems and sophisticated theme park rides). Over the past 20 years, AGRA Coast has been transformed from a "regular steel fabricator" to a world-class knowledge-intensive company involved in precision engineering, design and manufacturing.

4.1.3 Research Related to International Scientific Issues

International scientific issues are those that cannot be resolved without international cooperation in scientific research. Often, the results of those studies are the basis for international agreements. Examples include the following:

- Great Lakes pollution: The Great Lakes are shared by both Canada and the United States, and research regarding sources of pollution and abatement possibilities had to be carried out in both countries before an action plan could be developed.
- Fisheries: Since fish are not confined by national boundaries, stock assessment research for any particular stock has to be carried out in all the countries through which the fish pass during their life cycle.
- Surveillance of diseases: The carriers of disease are not confined by national boundaries; therefore, disease surveillance and prediction have to be part of a coordinated international effort.
- Monitoring of weather and climate developments: Weather and climate data collection and research also have to be coordinated between countries.
- Acid rain: Research regarding the sources of emissions, dispersion, damages and control strategies had to be carried out in both Canada and the United States before an agreement on how to address this problem could be reached.
- Climate change: This is clearly an issue that applies to all countries and that requires the coordinated S&T efforts of all countries to resolve.

There is some overlap between this category of activities (research related to international scientific issues) and the previous category (research through large-scale facilities and programs). The difference is that this category is defined by the international nature of the issue, not just by the size of the required research effort.

As can be deduced from the above list, many of the Canadian researchers involved in this category of activities are government researchers involved in environment and fisheries (and, to a lesser extent, energy and Northern affairs).

Research collaboration on international scientific issues

Fisheries and Oceans Canada (DFO) led a successful marine oceanographic program, Joint Ocean Ice Studies (JOIS), in the summer months of 1998. The JOIS program involved two Canadian Coast Guard icebreakers and more than 50 scientists from the United States and Japan conducting research in climate change, contaminants and marine ecosystem studies. Some of the research work became Canada's contribution to the Arctic Climate System Study (ACSyS) of the World Climate Research Program and addresses the primary goals of this 10-year multinational science program. International collaborations are continuing and expanding. Foreign partners in joint programs contribute not only their scientific expertise, but also operational resources and specialized equipment. This allows DFO scientists to be engaged in projects of much broader scope and larger scale than would otherwise be possible on the department's resources alone. The projects also showcase Canadian expertise in fields of critical importance for the future and contribute to the enhancement of Canada's image on the international S&T scene.

4.1.4 Research Related to International Economic Issues

This category of activities refers to issues related to those functionings of the economy that require agreement between Canada and other countries. Scientific research is often required to resolve these issues, and this research is by definition "international."

One of the most important types of scientific research carried out in this area is research related to standards of physical measurement, the system of weights and measures used to assess or describe the attributes of goods and services. This research enables international equivalency agreements to be reached (e.g. agreements between Canada and other countries that the method we use to measure a kilogram in Canada is equivalent to methods used in other countries). These agreements are necessary to conduct international trade. Without a method for measuring and valuing products, exchange and trade are simply not possible (or would at least be prohibitively expensive).[27]

Measurement is a very technical area, and the rapid pace of technology change has led to increasing demands for higher measurement accuracy and new standards.[28] Scientific research on measurement standards and techniques can have major economic benefits, as documented recently in studies carried out for the U.S. National Institute of Standards and Technology.[29] The following Canadian example is a good illustration of this.

Canadian industrial benefits resulting from an international agreement on measurement standards

Suppliers of bleached pulp products must be able to assure customers that the products meet certain agreed-upon standards of brightness. Brightness is measured by reflectance, and there are a number of different metrological techniques for measuring reflectance. A dispute arose in the mid-1980s between Canadian suppliers and their European customers regarding the method that should be used to measure reflectance. The measurement methods advocated by the Europeans would have required Canadian suppliers to add more bleach to their papers to increase its reflectance. Extensive research conducted by Canadian scientists was eventually successful in convincing European customers (and European measurement agencies) to accept the Canadian method. The resulting international agreement has been estimated to save Canadian producers a minimum of $100 million per year.[30]

Apart from physical measurement standards, there are many types of standards in which S&T plays a role. These are agreed on between countries in international or regional standards forums, such as the International Organization for Standardization, the International Electro-technical Commission, the International Telecommunications Union, the European Committee for Standardization and the European Committee for Electro-technical Standardization. S&T information is used by the various countries in developing their positions on standards under consideration; it is also used to resolve issues between countries.

In addition to standards-related agreements, there is a wide range of other international economic agreements which rely on S&T information in the development and implementation process. For example, the Commission for Environmental Cooperation established under the North American Free Trade Agreement uses S&T information in the resolution of disputes between countries regarding environmental issues.

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[27] Buyers seldom have the time or the ability to measure and qualify all the attributes of their purchases. They depend on standardized measurement systems to verify the information provided by the producers. Agreed-on standards of measurement enable trade to be conducted without high transaction costs.

[28] For example, as a result of ground-breaking research on the measurement of trapped single ion transitions, conducted recently by researchers at NRC, it is expected that the single ion standard will become the primary basis in Canada for measuring optical frequency and wavelength.

[29] Summarized in Albert N. Link, *Evaluating Public Sector Research and Development*, (Westport, Connecticut: Praeger Publishers, 1996).

[30] KPMG Consulting, "Evaluation of the Institute for National Measurement Standards," June 1999, p. 29-30.

Benefits to the Canadian beef industry from international S&T

Since 1989, Europe has banned the importation of U.S. and Canadian beef produced with growth hormones, such as estradiol, alleging that they were potentially cancer-causing. Both Canada and the United States opposed this ban on the grounds that it was not based on scientific evidence, and thus created an unjustified barrier to trade. Canada conducted a scientific review of all six growth-promoting hormones at issue and found them to be safe when used in accordance with good veterinary practices. In 1997, a World Trade Organization (WTO) panel ruled that there was no justification for the ban and that the European Union was in violation of its WTO obligations.[31]

4.2 Issues to be Addressed

4.2.1 Shortage of Resources for International Research Activities

A major issue is the limited, and declining, amount of funding available to support the international research activities of universities and government. Governments are the source of most of this funding. In Canada, the amount of government funding for R&D has declined significantly since the early 1990s. Federal expenditures on R&D decreased 11 percent in real terms between 1994–95 and 1998–99.[32]

Academic sector

Funding for university research was severely reduced in 1995–96. Although this funding has been largely restored, the funding available from the granting councils specifically to support international research collaboration is still less than it was 10 years ago. Many university researchers who made presentations to the Panel mentioned the lack of explicit Canadian funding for participation in the European Union's Fifth Framework Program and for activities conducted under government-to-government S&T agreements.[33]

In addition, the pattern of collaboration by university researchers over the past 20 years has shifted from heavy collaboration with American colleagues (which represented almost 50 percent of collaborations in 1980 and had decreased to 38 percent by 1995) to increased collaboration with other countries (especially Germany, Japan, Italy and smaller industrialized countries), which is more expensive.[34]

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[31] Compiled from:

1) Department of Foreign Affairs and International Trade and Agriculture and Agri-Food Canada, "Canada Retaliates Against the EU", News Release No. 174, 29 July 1999 and 2) Alberta Ministry of Agriculture, Food, and Rural Development, "EU Beef Hormone Panel," in *Agriculture Trade Information Quarterly*, Vol. 2, Issue 1, April 1998 (**http://www.agric.gov.ab.ca/trade/ati/ati9804b.html**)

[32] Statistics Canada, *Service Bulletin Science Statistics*, Vol. 22, No. 2, July 1998, p. 3.

[33] University researchers also frequently mentioned the "Canada clause," which is contained in the guidelines for some university research granting programs, such as the Networks of Centres of Excellence program, and which emphasizes benefits to Canada. This clause is seen as restricting international research activity.

[34] See previous reference at footnote 26, Brown, *Partners in Global Research*.

A potentially missed opportunity for important international research collaboration

Ellen Balka, a faculty member at Simon Fraser University, has been invited to participate, as the Canadian partner, in a funded EU Fifth Framework Project called "Estimation and Mapping of Employment Relocation in the Global Economy in the New Communications Environment." The project is concerned with mapping changes in the location of jobs, types of jobs performed in locations, and the movement of jobs between regions and countries. This is essentially a study of the impact of new information and communications technologies on shifts in the location of employment (e.g. the increased ability of employers to outsource in distant locations through the use of information and communications technologies). Among those likely to benefit from the outputs are government agencies involved in economic development, training, employment creation and equality of opportunity. Thus far, the project has received core funding of 2.1 million euros from the European Commission. However, these funds cover only the costs of work pertaining to EU countries. In efforts to raise funds for Canadian participation, Professor Balka has contacted more than six different agencies. Thus far, she has been successful in obtaining a grant of only $10 000. Should no other sources of funding become available in the future, this grant will not allow her to participate at the level anticipated by her European counterparts.

A missed research opportunity and a loss of Canadian talent

One of the most successful experiments in particle physics in the 1980s was an experiment called ARGUS, a collaboration of Canada–Germany–United States–Soviet Union, which was carried out at the DESY laboratory in Germany. The research findings included the discovery of BO–anti-BO oscillations. These are key factors in the modern experimental study of what is known as CP violation, a set of fundamental symmetries of the forces of nature. Following this discovery, the worldwide particle physics community embarked on a series of studies aimed at the experimental study of CP violation, including the development of new accelerator facilities and new experimental collaborations. One of these was a detector project known as BABAR, the headquarters of which was at Stanford University. The Canadian involvement in this project was led by Professor David MacFarlane of McGill University. At the time, he was on leave at the Stanford Linear Accelerator Center as a Steacie Fellow (one of Canada's most prestigious fellowships for young scientists). The Canadian participation also involved physicists from five other Canadian universities and the TRIUMF accelerator facility in Vancouver. The Canadian team was able to persuade the international BABAR Collaboration to let Canada take on the construction of part of the new detector (the central drift chamber). This would have given Canada a highly visible part in the experiment and demonstrated our ability to "pay our way" in the international collaboration. Unfortunately, the team was unable to secure sufficient funding from Canadian funding agencies, and the detector was financed primarily by the United States. In Professor MacFarlane's words: "From my perspective, it became clear that Canada was not willing to support the efforts of its best particle physicists at a level where they could compete on the international stage, in a manner commensurate with their talents, abilities and reputation." In 1997, Professor MacFarlane accepted a position at the University of California and, since that time, he has built up a research group that is almost as large as the entire team of Canadians participating in the BABAR project.

Government agencies

The federal laboratories in particular have been hard hit in recent years. As shown in Figure 8, federal funding for the principal SBDAs decreased 12 percent in real terms between 1994–95 and 1998–99 (14 percent if the Canadian Space Agency is excluded from the data).[35]

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[35] Derived from Table 1 and Table 6 in Statistics Canada, *Service Bulletin Science Statistics*, Vol. 22, No. 2, July 1998.

Figure 8

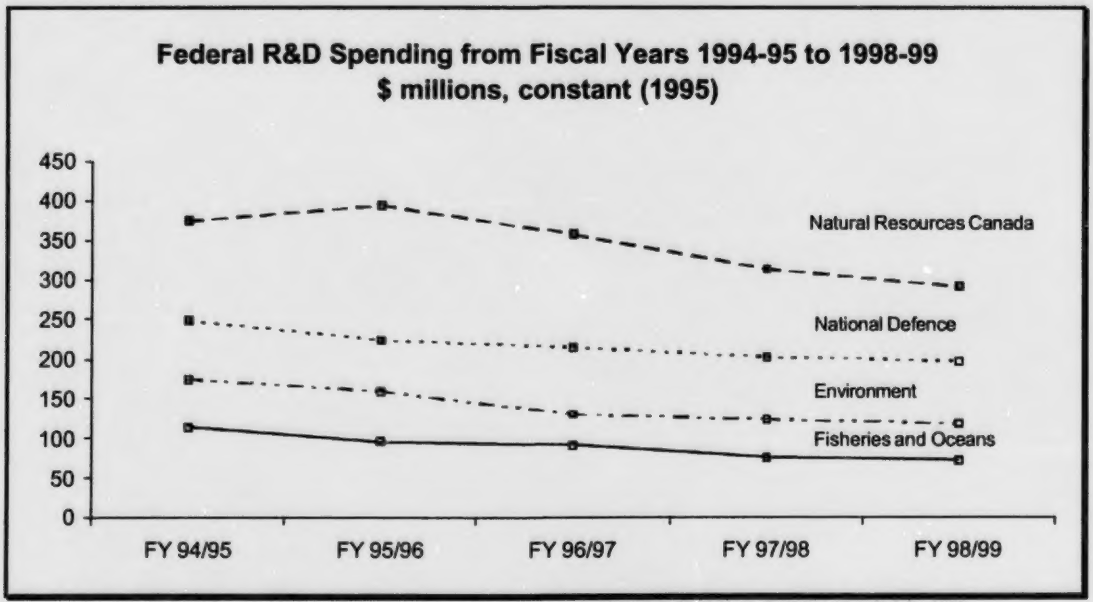
Federal R&D Spending from Fiscal Years 1994–95 to 1998–99
$ millions, constant (1995)

Department/Agency	Fiscal Year 1994–95	Fiscal Year 1995–96	Fiscal Year 1996–97	Fiscal Year 1997–98	Fiscal Year 1998–99	Decline Since 1994–95
Agriculture and Agri-Food Canada	323	319	336	294	299	7%
Canadian Space Agency	314	283	235	210	325	-4%
Natural Resources Canada	374	393	357	313	291	22%
Environment Canada	174	159	130	124	118	32%
Fisheries and Oceans Canada	114	96	91	75	72	37%
Health Canada	58	61	71	67	50	14%
Industry Canada	322	261	221	293	305	5%
National Defence	248	223	214	202	197	21%
National Research Council Canada	449	408	412	422	441	2%
Total	**2376**	**2203**	**2067**	**2000**	**2098**	**12%**

Source: Derived from Table 1 and Table 6 in Service Bulletin Science Statistics, V.22 No.2, Statistics Canada July, 1998

As shown in Figure 9, the funding of four of the largest federal government R&D performers has been reduced by an average of 28 percent. Also, although NRC's overall budget appears to have declined by only 2 percent, this is due to the increase in funding for IRAP. The reality is that appropriations to NRC for R&D in its laboratories have decreased substantially.

Figure 9



Source: Derived from Table 1 and Table 6 in Service Bulletin Science Statistics, V.22 No.2, Statistics Canada July, 1998

In most federal agencies, the majority of international R&D activities are funded from the agency's overall R&D budget. Therefore, the large decreases in agency R&D budgets have led to significant decreases in the funding available for international R&D activities.

In addition, the 1995 cuts led to sharp decreases in resources devoted specifically to international S&T within the federal agencies. For example, a number of those agencies (such as Agriculture and Agri-Food Canada, Natural Resources Canada, and Health Canada) eliminated or reduced their international divisions.

SBDAs and granting councils also cut their funding for international research programs and facilities. The following are some examples.

- Human Frontier Science Program (HFSP): This international program for collaborative research in neuroscience and molecular approaches to cellular functions is funded by the G7 countries (primarily Japan, Switzerland, and the European Union). In 1995–96, the Canadian contribution to the program, which was supplied by Industry Canada, was $722 000. Industry Canada eliminated this funding in 1996–97. The Medical Research Council of Canada and NRC are currently contributing some funding, but at a lower level. Canada will have to almost double its current contribution by 2002 to reach its agreed-on contribution level.

- Fusion: Funding for Canada's international activities in fusion research was eliminated at the end of the 1996 fiscal year. Canada's National Fusion Program was highly international in nature. The research effort was coordinated with fusion research in other countries under MOUs with the United States, Japan and the European Community. An independent review of Canada's program conducted in 1991 found that there was a solid rationale for this program, on both scientific and economic grounds, and that the program was of high importance to the world fusion effort.[36]

- International Institute for Applied Systems Analysis (IIASA): Canada was a founding member of this international research institute in 1972, with 11 other member organizations. Canada formally withdrew from the institute in 1997.

- The Canadian Genome Analysis and Technology Program: This program provided funding for peer-reviewed genome research and acted as Canada's link with the International Human Genome Project. Funding for this program was discontinued at the end of the 1996 fiscal year. Following this, Canadian researchers continued to participate to a limited degree in the international research effort, supported by traditional sources of research funding. However, the federal government has recently announced the creation of Genome Canada, with funding of $160 million over five years.

- There is currently very limited funding for Canadian participation on international scientific research committees. For example, Canada is a member of the International Arctic Science Committee, but the limited funding available to Canadian scientists has meant that Canada is not well represented in the research projects. Similarly, Canada is able to maintain its membership in the Scientific Committee on Antarctic Research (SCAR), but there are no funds available to engage in the level of research which is expected of Canada through the agreement. In fact, there has been a document distributed in the SCAR network called "The Canada Problem."

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[36] The ARA Consulting Group, "Evaluation of the Energy Research and Development Program," April 1991.

The history of Canada's participation in the Ocean Drilling Program

1984	Canada participated in the planning phase of the Ocean Drilling Program (ODP). Following that, Cabinet decided that Canada would become a full member of the ODP.
1989	Australia joined Canada in a membership consortium at a one-third membership level, and Canada reduced its contribution to a two-thirds membership level. Canada was designated as the head of the consortium.
1992	Canada announced that it could not continue to provide its contribution and that it would withdraw from the ODP in April 1993. After considerable protests from the national and international communities, Canada agreed to continue its participation at a one-third membership level. The ODP agreed to let the consortium continue its membership at a two-thirds level, provided that it agreed to make efforts to find new partners and bring the consortium up to a full membership level. Australia became the head of the consortium.
1996/97	South Korea and Taiwan joined the consortium at a one-sixth membership level each.
1999	Canada gave notice to the consortium and the ODP that it may be unable to meet its one-third contribution payment as of October 2000.
2000	It is expected that the consortium will be demoted to associate member status in the ODP, with no voting privileges on governing committees.

The above programs and projects represent specific examples of cutbacks. However, the most significant impact of the budget reductions resulting from the federal government's Program Review exercise in the mid-1990s has been the reduced opportunity for Canada's scientists, engineers and research organizations to participate in international collaborations (including exchanges, networks, joint projects and international partnerships).

Another point related to resources is the limited funding available to support Canadian students studying abroad. Presentations made to the Panel noted that lack of funds is by far the main barrier to having more Canadian students study abroad.[37] Likewise, there are few opportunities to bring into Canada the best and the brightest students from around the world.

4.2.2 Perception of Canada on the International S&T Scene

The factors outlined above have seriously eroded the perception of Canada as being an important and credible scientifically active country as well as a reliable partner. As one senior university official stated:

"Canada's image abroad is that of a freeloader, because we are being deceptive. We cut programs and yet expect others to pay for Canada. Either we are in or we are out."

4.2.3 Lack of a Coordinating Mechanism

A final issue is the lack of efficient mechanisms to coordinate and bring coherence to Canada's scattered international S&T activities. As several researchers noted to the Panel, the lack of priorities results in our international research effort being spread too thin. This, in turn, results in the lack of "critical mass" needed for Canadians to be recognized and to participate effectively. Critical mass is also required for Canada to reap the benefits of international S&T activities. Individual scientists working on their own or in small groups are much less likely to be able to exploit the benefits of scientific research than larger groups of researchers who are linked to other elements of the innovation system (industry, financial institutions, training institutions and so on). This issue is examined in greater detail in section 6.0.

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[37] Quebec has recently announced a $10-million fund to support students studying abroad.

5.0 TECHNOLOGY

This section deals with international S&T activities in support of Canadian industry. Much of the discussion focusses on SMEs, because of their importance in the Canadian economy.

The vast majority of Canadian businesses are SMEs: 96 percent of the roughly one million Canadian firms have fewer than 50 employees, and 78 percent of Canadian firms have fewer than five employees. Because of their large numbers, SMEs are of critical importance to the economy. For example, they account for

- 60 percent of total private sector employment and
- 60 percent of the new jobs created.

For all firms, SMEs included, the main factor affecting success and growth in today's globalized knowledge-based economy is the ability of the firm to innovate (i.e. to apply technological knowledge to the development of new products and services, the improvement of existing products and services, and the development or improvement of production processes).[38]

5.1 Current Activities

5.1.1 Activities to Acquire New Technologies and Technology Intelligence

Some new products and processes are based on technological information developed by firms themselves through the process of carrying out R&D. However, the majority are based on information acquired from other sources and adapted to the firms' needs.[39] As stated in the National Advisory Board on Science and Technology's (NABST) 1994 report on international S&T: "Small and medium-sized businesses told us of a real need for intelligence [including intelligence on scientific research and technologies]."[40]

Since the vast majority of new technological knowledge is developed outside of Canada, Canadian firms are very active in attempting to access this knowledge. This is done in a variety of ways: through information databases, through the Internet, by obtaining information from contacts and business partners in other countries (or from contacts and business partners in Canada who are knowledgeable about technologies developed in other countries), by obtaining information from Canadian government officials in other countries, through trips abroad, and so on. The research undertaken for the Panel indicates that the main sources of information for companies are international business contacts, followed by participation in conferences, symposiums and workshops.

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[38] Statistics Canada and Industry Canada, *Strategies for Success: A Profile of Growing Small and Medium-Sized Enterprises in Canada*, February 1994.

[39] See previous reference at footnote 11, Nelson, "The Simple Economics of Basic Scientific Research," in *The Economics of Technical Change*.

[40] National Advisory Board on Science and Technology, *Making the International Connection, Report of the Committee on International Science and Technology of the National Advisory Board on Science and Technology*, May 1994, p. 3.

However, as noted in the NABST report, "raw information is of little use to SMEs." What is needed is S&T intelligence, i.e., value-added information. This value-added information has to be specifically gathered, interpreted, collated and analysed by specialists who are very narrowly focussed.

There are no data on the amount of international technology intelligence-gathering activity by Canadian firms, but there are some data on the results of this activity. The data indicate that Canadian firms rely more heavily on foreign technology than do the firms of any other G7 country. The 1996 OECD study *Technology, Productivity and Job Creation* indicates that, in the mid-1980s, the United States and Japan imported less than 10 percent of their new technologies; Germany imported about 25 percent; France, about 37 percent; the United Kingdom, about 42 percent; Italy, about 48 percent; *and Canada, more than 65 percent.*

Firms need technological information not only for their use in the development of new products and processes, but also for competitive assessments, market planning and business planning. As one of the companies interviewed stated: "The objective of our company is to stay abreast of what others do and maintain our position as a world leader...." Similarly, the brief of an industry association to the Expert Panel states: "Providing the intelligence of what technological developments are taking place in the major developed countries would be of real service to the industry."

The acquisition and adoption of new technology by Canadian industry

In 1993, Global Thermoelectric, an Alberta-based company, received assistance from IRAP/NRC to license solid oxide fuel cell technology from Germany's largest research institute. After obtaining this new license, the company conducted preliminary research activities within the facilities of the Alberta Research Council prior to establishing its own fuel cell division. Through continuous research, this company has made significant progress in developing commercially viable production techniques for cell parts and is in the process of developing power supply products using the solid oxide fuel cell technology. The company is considered one of the leading companies in the world in the development of solid oxide fuel cells. The company is currently engaged in further solid oxide fuel cell research with a consortium of European companies and research institutes, and has recently struck an agreement with BMW.

5.1.2 International R&D Activities of Companies

Companies engage in international R&D for the same reasons university and government lab researchers do: to be able to work with the best researchers and have access to the best equipment and facilities worldwide. In addition, R&D is a good way to develop business links in foreign markets and build trust between partners.

The mechanisms used by industry are somewhat different from those used by universities and government. Many university and government organizations have arranged bilateral and multilateral MOUs with foreign organizations. Companies, on the other hand, tend to be more opportunistic, establishing international R&D programs based on current circumstances.

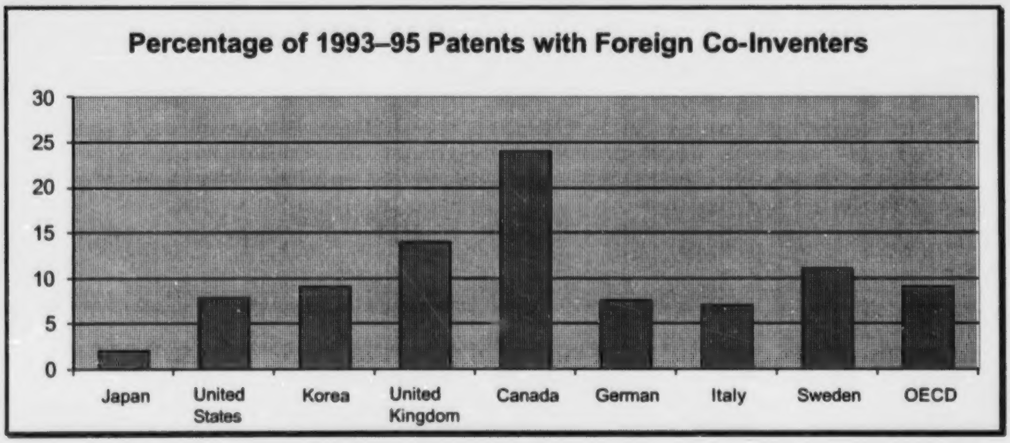
The following are two examples of business arrangements for international collaboration:

- Pratt and Whitney Canada is involved in a number of collaborative research programs with Canadian universities and Pratt and Whitney U.S. in Hartford. Due to a lack of Canadian facilities, the company works with NASA (the U.S. National Aeronautics and Space Administration) to test its engines at very high altitudes. The company is also involved in research consortia with its European partners, such as MTU in Germany and Fiat in Italy.

- CLINICARE Corporation is a software company specializing in electronic medical records solutions for medical group practices. It is currently involved in an international R&D project, funded under the EU Fourth Framework Program. The project involves the development of an Intranet Health Clinic solution using the Internet for chronic disease management. This project is being led by a principal investigator in Greece, with the additional involvement of research groups in Belgium and Spain, as well as the Alberta Research Council and the University of Alberta. The business arrangement is that CLINICARE and the University of Calgary will have exclusive use of the software in Canada, while the Greek principal investigator and the other partners will share other markets. The company's motivation for entering into this project was to leverage R&D from Europe.

The available data support a picture of a high level of international R&D activity by Canadian companies. Canada ranks *fourth in the world* behind the United States, Japan and the United Kingdom for technological alliances by firms with foreign partners. In 1995, there were more than 380 such alliances. In addition, 25 percent of Canadian patents are joint patents with foreign inventors. This is a considerably higher percentage than that of most other countries, as shown in Figure 10.

Figure 10



Source: OECD. *Science. Technology and Industry Scoreboard 1999: Benchmarking Knowledge-based Economies*. 1999. p. 81.

5.1.3 International S&T Activities of Government Intended to Support the Innovation Process for Canadian Industry

Government SBDAs are in a position to carry out a wide variety of international S&T activities in support of Canadian industry. The following are examples.

- Because SBDAs interact with the world's top R&D labs and with S&T organizations, they can provide *information to Canadian firms regarding new, promising or threatening, technological developments*. For example, NRCan's participation in the Coal Combustion research program of the International Energy Agency gave the department access to proprietary combustion data on foreign coals and novel burner design concepts. The Canadian coal industry has used this information for product development and for the identification of new markets.

- SBDAs can carry out R&D in other countries, which *facilitates access to markets* in those countries. For example, there is a large potential market for wood-frame housing in Japan, but the Japanese have restrictive standards and regulations, due to the great risk of natural disasters such as earthquakes. Canadian government researchers have been working collaboratively with Japanese researchers for about 10 years with the aim of demonstrating the ability of wood-frame housing to withstand great stress, thereby hoping to open up this market for Canadian industry.

- SBDAs can *open doors* for companies and *facilitate the formation of partnerships*. For example, the NRC's Institute for Microstructural Sciences involved a Canadian company, Brooks Canada, in a recent research collaboration with Nikon, which dealt with thin film control technology. The research was successful, and the technology was subsequently licensed to Brooks with Nikon as the end-user.

The potential of this set of activities was recognized by the 1994 Committee of NABST dealing with international S&T, which recommended increased efforts by SBDAs to assist Canadian SMEs:

> ...Government science-based departments and agencies should be mandated to track activity in the world's top research and development laboratories, in order to provide advance notice to Canadian firms of new promising, or threatening technological developments.... Canadian research and development establishments should encourage their scientists, engineers and managers to travel to enhance their connections with world-class research facilities and should promote exchanges of personnel between their laboratories and those abroad.... A new coordinated effort should be made to tap the knowledge of government scientists and the intelligence they gather, so that it can be disseminated most effectively to benefit Canadian business[41].

As discussed in section 2, the 1996 federal S&T strategy also encouraged SBDAs to increase their activities in this area.

Government international S&T activities in support of Canadian industry

Agriculture and Agri-Food Canada (AAFC) scientists at Harrow, Ontario, have been working for some time in a program supported by the Canadian Soybean Export Association and the Japanese Federation of Miso Manufacturers Cooperatives to create a niche market for premium quality Canadian food-grade soybeans in the Japanese market. "Harovinton" was the first food-grade soybean variety developed by AAFC. It was released for commercial use in 1989. Because of its premium quality, it is known in Asia as the "Asian pearl." This soybean is currently used to manufacture tofu and soy milk in Japan. Research is currently under way at AAFC to develop a new food-grade soybean variety specifically for use in the production of miso (a fermented soybean paste used in Asian cuisine).

Natural Resources Canada (NRCan) has had a long-standing agreement with Japan dealing with the exchange of technological information on energy-efficient housing. As a result of this agreement, NRCan officials built up a base of information regarding the Japanese market for Canadian housing technologies and building practices, and developed numerous contacts within the Japanese building industry. The department then used this information to assist Canadian companies to enter the market for super energy-efficient houses in Japan. They also assisted by demonstrating the technical attributes of these housing technologies to potential Japanese customers. There are now nine Canadian member companies and 16 Japanese partners of the Super E House Program. So far, 30 houses have been built, and an additional 12 houses are scheduled to be built this year. Japan is now Canada's largest overseas customer for manufactured housing and building products.

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[41] See previous reference at footnote 40, National Advisory Board on Science and Technology, *Making the International Connection*, p 5.

5.2 Issues to be Addressed

5.2.1 Lack of Financial Resources of SMEs for International S&T

A major issue in this area is the lack of catalytic financial resources, which makes it difficult for Canadian SMEs to carry out international S&T activities. This issue was mentioned frequently in the consultations conducted by the Panel, as illustrated in the following:

> "Finances are the most important hindrance. As a small organization, we don't have the manpower to be involved in things we want to be in."
>
> "There is a lack of seed money for participation."
>
> "There is a lack of timely financial support from either federal or provincial agencies ...."

The need of SMEs for financial assistance was documented in the 1994 NABST report on international S&T.[42] This barrier to participation in international S&T activities clearly applies more to SMEs than it does to large firms.

5.2.2 Difficulty of Obtaining Intelligence and Assistance Abroad

The NABST report also documented the need of SMEs for S&T intelligence:

> Small and medium-sized businesses told us of a real need for *intelligence* — more than just facts and figures — on technologies, research, markets and competitors' activities abroad. Unable to afford the resources necessary to monitor worldwide trends themselves, they rightly feel that relevant intelligence gathered by government officials should be made available to them. They need to know about new work in progress, as yet unpublished. They want government to provide not only up-to-date information databases, but also information with value added from Canadian contacts at home and/or posts abroad.[43]

The difficulties associated with accessing international S&T information were frequently mentioned in representations to the Panel. While respondents acknowledged that international S&T information may be being collected, they noted that there is no system that distributes this information to potential users. This was raised as an important impediment at the Panel meeting with STCs/TDOs.

A related need is for assistance abroad: assistance in accessing foreign technologies and in developing international partnerships. The majority of the SMEs the Panel consulted have no mechanisms or procedures for identifying international S&T opportunities or partners.

Other than IRAP (which does not have an explicit international mandate) and the Technology Inflow Program (which is very small), there are few mechanisms available to assist SMEs. Assisting SMEs falls within the area of responsibility of the TDOs. However, at present staffing levels, evidence suggests that the five existing TDOs are often unable to respond to more complex demands for assistance.

In addition, firms mentioned their needs for S&T intelligence, i.e., value-added information that requires a high level of expertise in specific domains. In the current structure, TDOs work as generalists and cannot be competent in all areas. They cannot provide the very focussed and value-added information that is often needed by the firms.

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[42] See previous reference at footnote 40, National Advisory Board on Science and Technology, *Making the International Connection*, p. 8.

[43] See previous reference at footnote 40, National Advisory Board on Science and Technology, *Making the International Connection*, p. 3.

The inadequacy of assistance abroad was frequently mentioned by the firms surveyed. For example, the Panel was told the following:

> "Canadian posts abroad fail to communicate potential opportunities to SMEs, as they either do not adequately screen incoming information, or they fail to provide any information. Posts do not have the capability to analyse the raw information. Canada tends to be a follower, when we could be a leader if we were better organized...."
>
> "There is no ongoing flow of information from posts abroad to help companies identify good opportunities — it's too little, too late."

5.2.3 Other Issues

Other issues mentioned by firms surveyed and interviewed include the following:

- the lack of a "single window" to facilitate access to government programs and services;
- the complexity of Canadian federal and provincial regulations;
- the non-applicability of the SR&ED tax incentive program to R&D conducted in other countries;
- the low level of industry participation in the development of government S&T policies;
- the limited participation of industry in international forums that set international standards;
- the poor linkages of Canadian firms with the new international trading system, in particular, the WTO.

A final issue is the lack of efficient mechanisms to coordinate and bring coherence to the scattered international activities of the SBDAs in this area. This issue is examined in section 6.0.

6.0 GOVERNMENT POLICIES

This section deals with the link between international S&T activities and the Canadian government's domestic and foreign policies. As stated in section 3.2, the main policy responsibility for S&T in the federal government rests with Industry Canada. However, the main policy responsibility for international activities rests with DFAIT. No one department has exclusive responsibility for international S&T matters.

The terms of reference for the Panel explicitly mention trade and investment policies; therefore, these are discussed first.

6.1 Current Activities

6.1.1 Support for Trade and Investment Policies

Support for trade policies has been dealt with, to some extent, in the previous sections. International S&T to support agreements between countries with respect to standards and reduced technical barriers to trade *(see section 4.1.4)* forms part of the necessary infrastructure for trade. As illustrated in the case examples, this can have dramatic impacts on trade. Also, the international S&T activities of companies *(see sections 5.1.1 and 5.1.2)* often have expanded trade as one of their objectives. There are strong linkages between R&D, investment and trade, as firms seek enhanced market access through investment or collaborative research with key players in the market. Trade follows investment, which is often nurtured through international collaborative R&D.

Finally, the government's international S&T activities that are intended to support the innovation process *(see section 5.1.3)* are often aimed, either directly or indirectly, at expanding trade. The following examples illustrate this:

- The Ontario government provides support (approximately $1 million per year) for the Ontario–China S&T Centre. This is now evolving into a trade incubator.
- The fostering of S&T cooperation between Canadian firms and Latin American firms is one of the methods being used by Canada to further its trade interests in Latin America[44].

Some of the provincial governments are actively using S&T activities to support expanded trade opportunities for provincial businesses. For example, the philosophy of the Science Council of British Columbia is to use "technology as a bridge to trade." The Science Council sees itself as a promoter and facilitator of relationships that have the potential to lead to trade opportunities. It helps to make introductions and provides a small amount of seed funding. For example, it was active in establishing an overseas marine science consortium that involves six B.C. companies. Part of its program involves an active effort to increase foreign awareness of the technology capabilities of B.C. companies.

The term "investment" in the question addressed to the Expert Panel refers primarily to Canada's efforts to encourage foreign direct investment in Canada. An example follows.

The role of S&T in attracting foreign direct investment

NRC's Biotechnology Research Institute has had a major impact in attracting foreign investment and strengthening the Montréal regional innovation system. This in turn has led to increased employment and other economic benefits for Canadians. The Institute has attracted foreign companies to Montréal on the strength of its reputation for expertise in the companies' respective fields and its sophisticated scale-up and bioprocess facilities. Examples include BioIntermediair (microbe-, animal cell-based production) from Holland and Intelivax (vaccines), Conjuchem (novel drug formulations), and Bioniche (immune system drugs) from the United States. The Institute has played an active role in attracting these companies through participation in international missions and the provision of information on its facilities and expertise.

There are some efforts by DFAIT to promote Canada's image abroad as a knowledge-based economy and, therefore, an attractive country in which to invest. However, the reduction in DFAIT's resources devoted to S&T *(see section 3.2)* and Canada's reduced participation in international S&T facilities and programs *(see section 4.1.2)* have had a negative effect on the perception of Canada on the international S&T scene.

Some of the international activities of the SBDAs contribute to Canada's international S&T image, but only a few of the SBDAs have an explicit policy to do this.

The survey responses to the question regarding what the respondents perceive to be Canada's image abroad were predominantly negative, as illustrated by the following:

> "Poor. Very little coordinated work at the international level. Mainly hinges on efforts of individual scientists."
>
> "Canada's image abroad is one of not pulling its weight in most scientific and technological activity...."

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[44] Paul Dufour et al., "Using Science and Technology as Strategic Instruments for Canada's Foreign Relations with Latin America," *Canadian Foreign Policy*, Winter 1998.

> "Good, but less committed to research and technology than would be expected for a first world economy."
>
> "At an individual or group level, Canadian researchers have an excellent image abroad, ...[but] Canada's image is relatively unknown."
>
> "Canada is better known for humanitarian assistance, peacekeeping and disaster relief than for science and technology...."
>
> "Canada has recognized pockets of scientific excellence, but overall [the country] is perceived as weak."
>
> "The image abroad still is that Canada is largely a resource-based economy, but with fledgling growth in science and technology...."
>
> "Canada is perceived a poor cousin, with good intentions and expertise but lacking a financial commitment to effective collaboration."

6.1.2 Support for Foreign Policy

S&T issues are becoming increasingly important in foreign policy. As noted previously *(see section 3.3),* this issue has been given a great deal of attention in the United States recently. The Panel feels, therefore, that it would be remiss not to discuss this issue briefly in this report.

The basis for the U.S. activity is a major report recently carried out by the U.S. National Research Council, *The Pervasive Role of Science, Technology, and Health in Foreign Policy.*[45] *(Note that the report addressed science, technology and health, and uses the acronym "STH.")* This report found that the importance of STH in foreign policy has greatly increased in recent years. The report states the following:

> Issues involving science, technology and health (STH) have moved to the forefront of the international diplomatic agenda. Other vital issues linked to technological developments pervade longer-range foreign policy concerns. Thus, the [State] Department must interact with other governments at a large number of bilateral and multilateral forums where STH considerations are central to the deliberations. STH aspects play a large role in discussions of such critical topics as nuclear nonproliferation, the use of outer space, population growth, adequate and safe food supply, infectious diseases, energy resources, and competitiveness of industrial technologies. In short, expert STH knowledge is essential in assessing many bilateral issues, global developments and interactions between countries of importance to the United States.[46]

These same statements hold for Canada, even though our foreign policies may have a slightly different focus. Much of the scientific information developed through international research collaboration *(see section 4.1.1)*, research projects related to international scientific issues *(see section 4.1.3),* and research projects related to international economic issues *(see section 4.1.4)* form the basis for Canadian foreign policies. Two examples follow.

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[45] See previous reference at footnote 21, U.S. National Research Council, *Science, Technology, and Health in Foreign Policy.*

[46] See previous reference at footnote 21, U.S. National Research Council, *Science, Technology, and Health in Foreign Policy*, p. 11.

The use of S&T information in negotiating an international agreement

In 1985, 24 countries signed the Vienna Convention for the Protection of the Ozone Layer. The participating countries agreed to take steps to protect the ozone layer and to cooperate in scientific research. Canada's part of this international research program was carried out by Environment Canada, which ultimately contributed about 10 percent of the worldwide knowledge base on ozone depletion and UV radiation. Conducting this research enabled Environment Canada to gain worldwide scientific credibility in this area, acquire the in-house expertise needed to interpret the research of other countries, and use this knowledge for policy analysis and international negotiations. The department's research was used in the development of Canada's position and in the negotiations of the Montréal Protocol. This agreement will have health benefits (e.g. resulting from the prevention of skin cancer and cataracts) and environmental benefits (e.g. resulting from the prevention of damage to fisheries and agriculture) for Canada of more than $1 billion.[47]

The use of S&T information in developing policies toward individual countries

S&T information, particularly information regarding the safety aspects of nuclear reactors, has been used in the development of Canadian policies toward several countries. In response to growing international concern about nuclear safety following the Chernobyl accident in 1986, Canada allowed certain countries to participate in the CANDU Owners' Group program for sharing non-proprietary, safety-related information. In 1990, Canada also authorized limited assistance under international auspices to address "serious and urgent" safety concerns at Canadian-supplied reactors. These policies could not have been developed without knowing what kind of information Canada might have to supply and the technical implications of supplying that information.[48]

The use of S&T information in developing foreign policy and the integration of S&T issues into foreign policy are the responsibility of DFAIT, but DFAIT's resources devoted to this are limited. However, this situation is not unique to Canada, as evidenced by the following findings of the U.S. report in reference to the U.S. State Department:

> At present, STH competence does not receive recognition as an important aspect of the culture of the Foreign Service, a shortcoming that is reflected in several ways:
>
> - STH activities are not high on the agendas of senior department officials; nor does STH competence weigh heavy during recruitment, training, assignment and promotion of foreign service officers (FSOs).
> - Many senior Department officials have little motivation to pay attention to STH-related issues, which may require delving into unfamiliar technical content with limited personal rewards for successful mastery of complex issues.
> - International STH programs of interest to other departments and agencies and to the private sector often receive low priority within the Department.[49]

Again, it is reasonable to assume that many of these same statements apply to DFAIT.

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[47] Marbek Resource Consultants, *Measuring the Impacts of Environment Canada's R&D: Stratospheric Ozone Depletion Research*, May 1998.

[48] Department of Foreign Affairs and International Trade, "Canadian Nuclear Non-Proliferation Policy Briefing", March 1998 **(http://www.dfait-maeci.gc.ca/agence-nand/nnpdla/english/nnpdla-6.html)**

[49] See previous reference at footnote 21, U.S. National Research Council, *Science, Technology, and Health in Foreign Policy*. p. 20.

6.2 Issues to be Addressed

6.2.1 Shortage of Resources for Policy Development

The shortage of resources for research and participation in international scientific committees, programs and facilities discussed in section 4.2.1 translates into a shortage of resources for the development of trade, science and foreign policies.

For example, in a presentation to the Panel, Canada's presence on the international scene in oceanography was described as follows: "Canada's presence today is not as strong as in the past. There are fewer Canadians holding office in international science organizations, fewer holding leadership positions in international research programs and fewer Canadians participating in international scientific meetings." This lower level of international S&T participation has an inevitable effect on our ability to develop sound Canadian government policies and our ability to influence the policies of other countries.

6.2.2 Lack of a Coordinating and Priority-setting Mechanism

One obvious issue relates to the activities of the federal SBDAs in this area. Few of them have articulated a strategy for carrying out their international S&T activities in a way that will support Canada's trade, investment and other policies, in spite of the fact that SBDAs are "required" to do this in the 1996 federal S&T strategy.

In addition, the following points were made a number of times in presentations to the Panel.

- There is currently a lack of efficient coordinating mechanisms for defining national priorities for international research activities. As a senior official of a federal government SBDA stated:

  > "There should be better coordination of international activities. National priorities should be based on increases in knowledge and economic benefits."

- There is no coherent policy on international S&T, and there is a need to identify and target strategic areas, as per the following quotes:

  > "Canada, like most countries, lacks the population and resource base to fully invest in all areas of scientific and technological research. While it is important to maintain a knowledge base in all disciplines, it is vital that the government identify strategic areas and target some of its investment to these priority areas. Once these strategic areas have been identified, we can determine which could most benefit from international collaboration. We must then focus our collaborations by partnering with the countries and international organizations that have world-class reputations in the priority areas. Canada can enhance its own contributions to world knowledge in these vital fields by gaining access to world-class research. This, in turn, will help put Canada on the world stage as a leader in science and technology."

  > "We cannot fund everything. Canada must make choices and fund at a reasonable level what it funds."

- There is no current overview information on the international S&T activities of government labs or universities.

- There are no efficient mechanisms for

  - assessing the extent to which Canada's participation in major international programs and affiliations supports government policies and

  - ensuring stability, when warranted, for Canada's participation in international S&T activities.

6.2.3 Perception of Canada on the International S&T Scene

A second issue is that Canada's international S&T image is perceived to be poor, and not at all in line with our S&T capabilities. This is a significant challenge in that it involves changing Canada's image to that of a knowledge-based economy. DFAIT has limited resources for promoting Canada's image. The situation has been made worse by the cutbacks in our international S&T efforts. It is felt that this perceived poor image has a limiting effect on foreign direct investment.

6.2.4 Leadership

Many presentations to the Panel expressed a high level of dissatisfaction with the way in which the government, particularly DFAIT, has supported Canada's international S&T activities. This has already been discussed in previous sections.

With regard to setting priorities for the international activities of federal SBDAs *(see section 6.2.2),* there has not been the needed coordination between the two lead agencies, DFAIT and Industry Canada, to create the necessary synergy and critical mass.

A number of presentations also referred to the need for an international S&T strategy for Canada (and many also mentioned the need for an overall S&T strategy). The Panel would like to note that it is not in a position to address this. The 1996 federal S&T strategy explicitly leaves the decision making and accountability for international S&T activities to the individual SBDAs. The Panel is, however, recommending a mechanism that is intended to address the lack of coordination among SBDAs *(see section 7.2).*

6.2.5 Link Between International S&T and Foreign Policy

Finally, it may be the case that S&T issues and the use of S&T information have not been fully considered in Canadian foreign policy development, thereby limiting the effectiveness of our policies. The Panel was unable to investigate this, but there are good reasons for believing this may be the case, as it apparently is in the United States. It clearly is the case that there is no effective mechanism for coordinating our foreign policies with the international S&T activities of the federal SBDAs.

7.0 RECOMMENDATIONS

7.1 Vision

The Panel's vision is that, over the next decade, Canada's status in international S&T will change: from that of a relatively minor player in S&T interactions with other countries to that of an important and valued participant in the international S&T community, and a world leader in those areas of S&T in which Canada is strong.

Canada's image must be changed to that of a knowledge-based economy and one where S&T adds value to natural resources and other sectors. The following factors are part of this image change:

- Our scientific research community must become known for its research leadership and not just the competence of individual researchers.
- Our firms must continue to be among the most innovative in the world.
- Our government policies must be fully informed by the latest S&T knowledge.

In order to accomplish this, Canada must become a champion and a model of international S&T collaboration. Canada must develop programs and policies that set an example to the world and that take maximum possible advantage of international S&T opportunities in a timely fashion, in support of advances in scientific research, industrial innovation by Canadian firms and improvements in the quality of life for Canadians.

7.2 Recommendations

The recommendations below will enable Canada to achieve this vision. Based on the evidence reviewed, the Panel believes that Canada has the intellectual and industrial strength to be a world leader in many areas of S&T. What we need is an efficient mechanism to define international S&T priorities, better coordination and more resources. The Panel believes it is imperative that the Canadian government fully recognize the value of international S&T activities and provide the tools, mechanisms and financial support to conduct these activities.

Recommendation 1: Science

The first recommendation is intended to address the following issues, which are discussed in section 4.2:

- the critical shortage of resources for international S&T activities and
- the perceived erosion of Canada's credibility as an important scientifically active country and our reputation as a reliable partner.

Recommendation: The 1996 federal S&T strategy states that international activities should support domestic needs and that the various government departments and agencies are responsible for their international activities.

Within this strategy, the Panel recommends that the federal government create a special fund to encourage the scientific community to foster international cooperation. This fund would be accessible to the academic, government and private sectors as a contribution of limited duration to projects and initiatives. The fund is not intended to replace core funding in government departments and agencies.

The fund should provide additional support, when needed and on a competitive basis, for the following:

- international partnerships and collaborative research, including multi-sector partnerships;
- Canada's participation in international programs;
- Canada's access to international facilities;
- Canada's participation in international S&T organizations; and
- Canadian participation in activities under bilateral and multilateral government-to-governmentS&T agreements.

The allocation of funds should be based on excellence as determined by peer review (where applicable), strategic needs as identified by the Executive Committee proposed in Recommendation 3, and impact on innovation, and it should give full consideration to the provincial international S&T strategies.

The fund should be managed by a non-departmental federal organization and evaluated on a five-year cycle.

The Panel believes that the fund will enhance Canadian participation in key international endeavours, ensure its continuity when appropriate and, as a result, restore the visibility and credibility of Canada on the international S&T scene.

Additional Discussion: The Panel recommends that the budget for the fund be a minimum of $150 million per year. This amount is about 5 percent of annual federal expenditures on S&T (not counting foregone government revenues as a result of the SR&ED tax incentive program). The Panel believes this is at the low end of the amount required to restore our highest priority international S&T commitments and take advantage of the most important international opportunities to strengthen Canadian research. This budget could be provided either through an annual allocation from the federal government or through the annual income from an endowment supplied by the federal government.

Note that the Panel recommends that the fund be managed by a non-departmental federal organization. The Panel considered, but is recommending against, the management of the fund by a federal government line department. This is to avoid the perception of conflict of interest (since government departments should be able to apply to the fund) and because of the difficulty departments would have in making decisions regarding the S&T activities of other departments. The Panel is also *recommending against the creation of a new organization to manage the fund*. There is sufficient expertise available to do this job within existing agencies, for example, within the granting councils, the Canada Foundation for Innovation (CFI) or NRC.

Although a number of participants indicated that they expected the Panel to address the question of prioritization of Canadian researchers' needs in this recommendation, the Panel noted that its Terms of Reference asks for mechanisms to address this question. The Panel's recommended mechanism for prioritization is dealt with in Recommendation 3.

There was considerable discussion within the Panel of whether or not government departments and agencies should be able to apply to the fund. It was decided that, if this were not allowed, many excellent international S&T opportunities would be missed. Furthermore, it is the Panel's belief that the fund should be accessible for high-quality international scientific collaboration involving researchers from all sectors of the Canadian scientific community. At the same time, the Panel is quite serious about the phrase "not intended to replace core funding." Note also the phrase "additional support." In general, the fund is intended to provide funding that supplements other funding already in place.

The fund could be divided into two components: one based on agreed-on priorities for international S&T and the other responsive to identified opportunities. The fund is intended to encourage partnerships. Also, although not explicitly stated in the recommendation, the fund could be used to support Canadian students studying abroad or visits to Canada by students from other countries. The fund should recognize the value of creating opportunities for international recruitment and mobility of highly qualified personnel.

Note that funds are intended to be allocated on a competitive basis through a timely peer review process, where applicable. The Panel has suggested the criteria that should be used in this process: scientific excellence, strategic needs and impact on innovation. Also, as much as possible, the fund should rationalize its applications process to avoid the need for dual applications.

The phrase "of limited duration" in the recommendation is intended to prevent the use of the fund for financial commitments that are likely to continue forever, more or less automatically. All commitments would need to be re-assessed on a regular basis.

The Panel believes that the management of the fund should be entrepreneurial rather than bureaucratic.

Recommendation 2: Technology

This recommendation is intended to address the difficulties faced by Canadian SMEs in carrying out international S&T activities due to the lack of information on opportunities and the lack of financial resources *(see section 5.2)*.

Recommendation: Given that Canadian SMEs are the fastest-growing part of the Canadian economy in terms of job creation, and that SMEs are largely dependent on international new technology business development, the Panel recommends that a new mandate with additional resources be given to the Industrial Research Assistance Program of the National Research Council Canada (IRAP/NRC) to support the international S&T endeavours of Canadian SMEs.

Under this new mandate, in cooperation with DFAIT and other partners (as appropriate), and in accordance with the guidance of the Executive Committee proposed in Recommendation 3, IRAP/NRC should undertake the following:

- gather and analyse strategic technology intelligence and funding opportunities on the international scene;
- access and assess technologies developed abroad, through visits, technology missions, networking and partnering events; and
- through these activities, support SMEs in setting up international technology-based ventures to enhance their development; this support would be provided for the identification of potential partners, negotiation of intellectual property rights, and preparation of submissions for accessing international funding programs and feasibility studies, as needed, for the benefit of the Canadian economy.

The Panel believes that this new mandate should enhance the development of Canadian SMEs, improve their market access, increase their competitiveness in the economy and provide a focal point for the international S&T endeavours of SMEs. The Panel believes that IRAP/NRC is the pre-eminent organization for such an activity, as its network is highly decentralized, but connected nationally and internationally.

Additional Discussion: The Panel's estimate of the additional funding that would be required by IRAP to carry out this role is approximately $20 million per year.

The Panel also considered the following two alternative models to IRAP:

- The model of the Swedish Office of Science and Technology. Although it has some appeal, this model would be inadequate because it deals only with the gathering and dissemination of S&T information through the S&T counsellor network. It does not contain an in-country component of relationship-building with SMEs to assist them in identifying their needs and help them in accessing useful information, setting up partnerships, dealing with regulations, and so on. This component is considered essential by the Panel.
- Extending to other countries the model of the Canada–Israel Industrial R&D Foundation (a private sector foundation that provides funding for R&D alliances between Canadian and Israeli firms). It was felt that, although a successful model, it would be difficult to apply this program to other countries (i.e. Israel is a special case for a number of reasons).

The IRAP program, with its existing nationwide network of industrial technology advisors who have relationships with thousands of Canadian SMEs, would be ideally suited for this role. IRAP is already involved in assisting SMEs with the innovation process, but the program currently lacks an explicit international mandate.

The Panel feels that the existing level of cooperation between NRC and DFAIT should be strengthened. It is expected that IRAP industrial technology advisors would rely on the existing DFAIT network, particularly the TDOs, to assist with the acquisition of S&T information abroad. In cases where the TDOs may not have the required specialized expertise, the Panel recommends that specialists be retained, as indicated in Recommendation 3.

Recommendation 3: Government Policy

This final recommendation relates to the issues discussed in section 6.2. It is intended to address the current lack of a mechanism for even limited coordination of the international S&T activities of different SBDAs, including the following:

- a mechanism for developing priorities for the government's international S&T activities; and
- a mechanism for identifying ways in which the government's return on its investment in international S&T can be maximized.

It also addresses the following:

- the need for explicit recognition of the importance of S&T underlying many domestic and foreign policies, and
- the need for more effective monitoring of and response to developments on the international S&T scene.

Recommendation: The Panel believes that S&T is critical to the development of a knowledge-based society, and it recommends that S&T be included in Canada's foreign policy.

In addition, the Panel recommends the following:

- **The responsibility for international S&T should be assumed by an executive committee to be chaired jointly by DFAIT's Deputy Minister, International Trade and Industry Canada's Deputy Minister.**
- **The membership of this executive committee should include major S&T stakeholders and the heads of the organizations that will manage the new funds for international activities.**
- **This committee should be responsible for**
    - **defining Canada's international S&T policy;**
    - **coordinating Canadian decentralized international S&T activities, i.e., it should**
        1. **identify areas of overlap and duplication, and assist in their mitigation;**
        2. **identify gaps in essential requirements, and help ensure they are bridged;**
        3. **note activities offering potential synergy, and foster cooperation;**
        4. **provide oversight to the organizations managing the new funds; and**
        5. **assess the activities funded on a regular basis in order to determine their continued relevance; and prepare and maintain an inventory of international activities supported by the government and report on those activities on an annual basis.**
- **In countries identified as being key for the implementation of the international S&T policy, DFAIT heads of mission should be specifically charged in their mandate letters with personal responsibility for the delivery of the S&T program, and their performance should be assessed through the annual appraisal process.**

The Panel also believes it is essential that the needs of Canada's academic, government and private sectors to constantly monitor and respond to the rapid developments on the international S&T scene be addressed in an increasingly relevant and timely fashion. As a result, the Panel recommends that the executive committee also be responsible for defining the number, the selection criteria, tasking, geographic location, and re-allocation of DFAIT's STCs and TDOs. The Panel recommends that these positions be allocated through a well-advertised competitive process open to the academic, government and private sectors, and that a thorough assessment be conducted at the end of these postings.

Additional Discussion: The recommendation that "S&T should be included in Canada's foreign policy" means that S&T considerations should be systematically addressed in foreign policy deliberations and that DFAIT should give S&T a much higher priority.

In formulating Recommendation 3, the Panel carefully considered a number of alternatives for assigning responsibility for a coordinating and policy role. The Panel reviewed the models used in other countries and in Canada and, in particular, the model of Investment Partnerships Canada. This latter model is recommended by the Panel, because it is a sensible way of dealing with the joint role of Industry Canada and DFAIT in international S&T. The Panel also noted that this organizational model appears to be working well in the case of the Investment Partnerships Canada program.

The Panel feels it is very important that this executive committee be supported by a secretariat headed up by someone of stature coming from outside the government. It also feels that the executive committee must receive and take into consideration input from all parties, i.e., federal government, provincial governments, and academic and private sectors.

The part of the recommendation dealing with the STCs and TDOs is intended to provide a realistic response to the clear need for improving these capabilities. Since Canada cannot afford to hire large numbers of permanently located international S&T officials, the Panel has recommended a more flexible arrangement. The executive committee would be responsible for identifying the needs, which will obviously vary from time to time. STCs and TDOs would then be hired or seconded and posted, on the basis of these needs, in specific locations and for specific time periods.

7.3 Additional Comments of the Panel

A number of additional points were raised in presentations to the Panel and at the regional workshops, which the Panel wishes to comment on.

1. **The need for national S&T priorities.** Many presenters to the Panel stressed the need for Canada to set priorities for S&T in Canada *(see, for example, the quotes in section 6.2.2.).* The Panel agrees with the need to define S&T priorities in order to ensure "critical mass" for Canada's international activities and it supports any efforts to develop national S&T priorities. The Panel would like to suggest that the process involve the Canadian Learned Societies. However, this is an enormous challenge. For example, a recent survey of 50 leading innovative firms, 12 leading research universities, and all federal government departments involved in significant R&D programs found that Canada's capacity to define strategic research priorities based on concrete information is very limited.[50] The Panel has addressed this to the extent possible for international S&T in Recommendation 3.

   In addition, in a number of briefs to the Panel and at the workshops, the need for Canada to develop a national S&T strategy was mentioned. (The 1996 federal S&T strategy was not considered by most commentators to be much of a strategy by most commentators). The Panel did not feel it was in its mandate to address this issue.

2. **International S&T to achieve domestic needs.** A number of briefs received by the Panel as well as a number of presenters to the Panel have argued that, in the current globalized system, the focus on domestic needs is too limiting. The Panel felt that it did not have the competence to address this issue as this would involve an in-depth review of the 1996 federal S&T strategy.

3. **Coordination of federal SBDAs.** A related comment was the need for a greater degree of coordination of the S&T activities of the federal SBDAs. This is discussed throughout this report *(especially in section 6.2.2),* and,

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[50] The Partnership Group for Science and Engineering, *Setting Priorities for Research in Canada*, May 1999.

as with point 1, the Panel has addressed this to the extent possible for international S&T activities in Recommendation 3. The difficulties associated with attempting to coordinate the activities of different federal departments and agencies in Canada are legendary, and there have been numerous failures. The Panel is hopeful that the proposed executive committee will be able to achieve some degree of coordination of international S&T activities on the basis of the very obvious need for coordination in this area, combined with the fact that the international S&T activities of federal SBDAs form a relatively small part of their total S&T activities (and, therefore, some degree of coordination should be relatively unthreatening).

4. **The SR&ED tax incentive program.** This program is an extremely important program for Canadian industry, and many industry presenters made the point very forcefully that the non-applicability of the program to R&D conducted outside of Canada is harmful to them and to the Canadian economy in general. The Panel would like to suggest that this issue might be worth reviewing.

5. **Development of S&T capacity in developing countries.** This is an important area of activity for CIDA, IDRC and, to a lesser extent, other government SBDAs (e.g. NRC). Several participants in the regional workshops commented on the lack of discussion of these activities and the associated issues in the report. The Panel felt that the analysis of these issues was beyond the scope of its mandate.

6. **The indirect costs of university research.** A number of university presenters to the Panel commented on the challenges currently faced by universities in funding the indirect (overhead) costs of university research. This is clearly a major issue in Canada. The federal government has restored the budgets of the university research granting councils in recent years and introduced several excellent new programs, such as the Networks of Centres of Excellence (NCEs) and the CFI. However, all of these cover only the direct costs of university research, and all increases in direct research expenditures trigger concomitant increases in indirect research costs. One participant in the regional workshops even said: "It's useless to give university researchers any more money for direct research costs without corresponding funding for indirect research costs." The Panel has considerable sympathy with these sentiments. However, the Panel felt that the analysis of this issue was beyond the scope of its mandate.

7. **The "Benefit to Canada Clause."** A number of university research presenters referred to the "Benefit to Canada Clause" associated with federal university research funding programs and the limiting effect of this clause on international research collaboration. It was argued that time is critical and that delays in dealing with foreign companies may severely limit trade opportunities. This is discussed further in point 8.

8. **Restrictions regarding funding international activities.** As this issue was raised, the Panel investigated the restrictions of university research granting programs (including the NCE program and the CFI program) on international activities, partnerships and expenditures. The Panel found that there are very few restrictions and that the restrictions that do exist are reasonable. The restrictions associated with the granting council and CFI programs are minimal, and the only restriction associated with the NCE program relates to the use of intellectual property resulting from network-funded research. (Essentially, the owners of network-funded intellectual property are supposed to try to license the intellectual property to Canadian companies.) Therefore, the Panel simply wishes to encourage the granting councils and the CFI administrators to be as flexible as possible with regard to decisions that may limit the scope of international research collaborations.

   However, to the Panel's knowledge it is not possible to fund activities carried out abroad by foreign researchers. The Panel would like to suggest that this issue might be worth reviewing.

9. **Inclusion of health as part of "S&T."** Several presenters mentioned that they felt health issues should explicitly be added to the scope of the Panel's recommendations, particularly in relation to foreign policy, as has been done in the United States. The Panel felt this was beyond its scope, since the scope of its parent body, the Advisory Council on Science and Technology, is limited to science and technology in the traditional sense (i.e. natural sciences, social sciences and engineering).

10. **Harmonization process for applications for funds.** Many presenters commented on the diversity and the number of funding applications that exist in Canada, and emphasized the need for more harmonization of the application processes. The Panel agrees with the desirability of more harmonization, but felt that this is a government-wide issue that is beyond the scope of the Panel's mandate. The Panel has commented on the importance of rationalizing the application process for the new fund.

    Many presenters also mentioned the need for "one window" shopping regarding Canada's international activities. The Panel agrees that this would be very useful and efficient. However, the Panel felt that the analysis of this issue was beyond the scope of its mandate.

* This list is not exhaustive and is based on information obtained from SBDAs and the Department of Foreign Affairs and International Trade (DFAIT).

Notes: 1) Sections A and B include programs and projects that involve researchers from more than one organization.

2) In all sections, lists are in decreasing order of funding amounts for fiscal year 1999–2000. Only activities requiring funding of more than $10 000 in 1999–2000 are included.

3) As of June 2000, the Medical Research Council of Canada has been replaced by the Canadian Institutes of Health Research.

ANNEX A

Panel Work Plan

The work plan was structured around three main steps. These steps were not strictly sequential, as a number of activities were conducted concurrently.

Step 1: Gathering and Assessing Available Information

The Expert Panel gathered and critically examined information on the following:

1. the scale and scope of Canada's international activities;
2. the policies developed over the past several years (or that are currently being developed) by key stakeholders;
3. the contributions of international S&T to Canada's economic and social agendas in support of trade, the development and dissemination of knowledge, and the attraction of foreign direct investment or other wealth-generating activities;
4. the barriers to Canada's role in international S&T, be they legal, structural, financial or of any other nature;
5. the best practices in other countries;
6. the outcomes of events (conferences, workshops, symposiums and so on) that touch on its mandate.

This was done by means of a survey that included selected stakeholders from the government, and academic and private sectors, by interviews of key stakeholders from those sectors, and commissioned studies or events, as needed.

Step 2: Consulting Key Stakeholders

In addition to the survey and interviews mentioned in Step 1, panellists met informally with selected stakeholders over several months. These meetings provided stakeholders with an opportunity to share their views on how the Panel's report might best meet stakeholders' needs.

The Panel also hosted regional workshops to test and validate the conclusion of its draft report before publishing its final report.

Step 3: Developing and Publishing a Final Report

On the basis of the information collected and critically examined, the Panel developed its draft report. The report offers directional recommendations with a view to facilitating Canada's participation in international science opportunities and Canada's access to international S&T intelligence, and of enhancing Canada's image on the international scene.

Taking into account the comments received at the regional workshops and through other consultations, as appropriate, the Panel published its final report.

ANNEX B

Panel Solicited Stakeholder Input

Part I: Presentations Made to the Panel

Section A	Representatives from Industry Associations
Section B	Representatives from Business Associations
Section C	Representatives from Academic Associations
Section D	Representatives from the Federal Government
Section E	Representatives from Canadian Embassies Abroad
Section F	S&T Representatives from Selected Foreign Countries

Part II: Chairman's Meetings with Key Senior Officials

Part III: Participants in the Panel's Regional Workshops

Location	Date
Halifax	24 May 2000
Ottawa	26 May 2000
Montréal	31 May 2000
Toronto	2 June 2000
Calgary	6 June 2000
Vancouver	7 June 2000

ANNEX B

Panel Solicited Stakeholder Input
Part I: Presentations Made to the Panel

Name	Title	Organization	Date
Section A: Representatives from Industry Associations			
Duncan, Gaylen	President and CEO	Information Technology Association of Canada	25 February 2000
Hough, Paul	Vice-President	BIOTECanada	25 February 2000
Marcheterre, André	President	Canada's Research Based Pharmaceutical Companies Association	25 February 2000
Marsters, Gerry	Chair, Technology Council	Aerospace Industries Association of Canada	25 February 2000
Pelletier, Debbie	Director, S&T Network	Alliance of Manufacturers and Exporters Canada	23 November 1999
Wright, Joseph	President	Pulp and Paper Research Institute of Canada	25 February 2000
Section B: Representatives from Business Associations			
Rhéaume, Gilles	Vice-President, Innovation and Regulatory Affairs	Conference Board of Canada	25 February 2000
Rothschild, Henri	President	Canada-Israel Industrial R&D Foundation	25 February 2000
Section C: Representatives from Academic Associations			
Brown, Sally	Senior Vice-President	Association of Universities and Colleges of Canada	23 November 1999
Section D: Representatives from the Federal Government			
Clarke William L.	Assistant Deputy Minister, International Business, and Chief Trade Commissioner	Department of Foreign Affairs and International Trade	23 November 1999 25 February 2000
Everell, Marc D.	Assistant Deputy Minister, Earth Sciences Sector	Natural Resources Canada	23 November 1999
Lyrette, Jacques	Vice-President, Industry and Technology Support	National Research Council Canada	25 February 2000
Nadeau, Serge	Director General, Micro-Economic Policy Analysis Branch	Industry Canada	23 November 1999
Section E: Representatives from Canadian Embassies Abroad			
Alexander, John	Commercial Officer	Canadian General Consulate, Atlanta, USA	25 February 2000
Bhaneja, Bill	S&T Counsellor	Canadian Embassy, Berlin, Germany	25 February 2000
Deacon, Pamela	Counsellor (OECD)	Canadian Embassy, Paris, France	25 February 2000

ANNEX B

Panel Solicited Stakeholder Input

Part I: Presentations Made to the Panel

Name	Title	Organization	Date
Gagné, Claude	S&T Counsellor	Canadian Embassy, Brussels, Belgium Canadian Mission to the European Union	25 February 2000
Hicks, Philip	S&T Counsellor	Canadian Embassy, Tokyo, Japan	25 February 2000
Lafeuille, Denis	Technology Development Officer	Canadian Embassy, Paris, France	25 February 2000
Leclerc, Gilles	Counsellor (Space)	Canadian Embassy, Paris, France	25 February 2000
Pearce, John	Consul and Senior Trade Commissionner (former Counsellor, Commercial)	Canadian Embassy, Helsinki, Finland	25 February 2000
Sangmyum	Commercial Officer	Canadian Embassy, Seoul, Korea	25 February 2000
Sotvedt, Jim	Deputy Consul General and Senior Trade Commissioner	Canadian General Consulate, Boston, USA	25 February 2000
Webb, Robert	S&T Counsellor	Canadian Embassy, Washington, USA	25 February 2000
Wiest, Bruno	Technology Development Officer	Canadian Embassy, Berlin, Germany	25 February 2000
Section F: S&T Representatives from Selected Foreign Countries			
Abels, Bernhard	First Secretary, Economic Affairs	Embassy of the Federal Republic of Germany	25 February 2000
Bolright, John	Executive Director, International Affairs	U.S. National Academy of Science	20 March 2000
Deeg, Frank	S&T Counsellor	Delegation of the European Union in Ottawa	25 February 2000
Lisson, Frances	Deputy Commissioner	High Commission of Australia	25 February 2000
Otsuka, Yoichiro	Director, International Affairs	Science and Technology Agency, Japan	25 February 2000
Uden, Martin	Economic Counsellor	High Commission of the United Kingdom	25 February 2000
Razungles, Jean	S&T Counsellor	Embassy of France	25 February 2000

ANNEX B – PART II

Panel Solicited Stakeholder Input
Part II: Chairman's Meetings with Key Senior Officials

Name	Title	Organization	Date
Clarke, William	Assistant Deputy Minister, International Business, and Chief Trade Commissioner	Department of Foreign Affairs and International Trade	14 March 2000
Emmett, Brian	Acting President at the time of the meeting, Vice-President, Policy Branch	Canadian International Development Agency	14 March 2000
Gabolde, Jean	Directeur, Direction – Rôle international, Direction générale de la recherche	European Commission	2 May 2000
Giroux, Robert	President	Association of Universities and Colleges of Canada	10 February 2000
Goldenberg, Edward	Senior Advisor to the Prime Minister	Prime Minister's Office	3 April 2000
Harder, Peter	Deputy Minister	Industry Canada	17 April 2000 1 September 2000
Leiss, William	President	The Royal Society of Canada	17 April 2000
Lynch, Kevin	Deputy Minister	Finance Canada	17 April 2000
Lyrette, Jacques Cooper, Denys	Vice-President, Industry and Technology Support Director, Strategic Alliances, Industrial Research Assistance Program	National Research Council Canada	17 February 2000
Normand, Gilbert	Secretary of State, Science Research and Development	Industry Canada	8 September 2000
O'Neil, Maureen	President	International Development Research Centre	15 March 2000
Ready, Robert	Director, International Investment and Services Policy	Industry Canada	17 February 2000
Renaud, Marc	President	Social Sciences and Humanities Research Council of Canada	15 May 2000
Rothschild, Henri	President	Canada-Israel Industrial R&D Foundation	17 February 2000 15 June 2000
Slater, Robert	Co-Chairman	Assistant Deputy Minister, Science Committee	10 February 2000
Strangway, David	President	Canada Foundation for Innovation	10 February 2000
Sulzenko, Andrei	Assistant Deputy Minister, Industry and Science Policy	Industry Canada	26 April 2000
Wright, Robert	Deputy Minister, International Trade	Department of Foreign Affairs and International Trade	21 November 1999 16 May 2000 16 August 2000

In addition, the Chairman was also invited to meet with the following:

- Vice-Rectors and Deans of the Université de Montréal on 13 April 2000
- Partnership Group for Science and Engineering on 17 February 2000
- University Advisory Group / Industry Canada on 12 April 2000 (the Panel Secretary represented the Chair at this meeting).

ANNEX B – PART III

Panel Solicited Stakeholder Input

Part III: Participants in the Panel's Regional Workshops

Halifax Regional Workshop

Wednesday 24 May 2000

Chair: Dr. Joanne Jellett, Panel Member

Name	Title	Organization
Bangay, Garth	Regional Director General	Environment Canada
Boyd, Robert	Director General	Institute for Marine Biosciences, NRC
Chard, Sharon	Regional Director	Health Protection Branch, Health Canada
Cooper, Linda	Director, Technology and Industry Development	Industry, Trade and Technology, Newfoundland
Deveau, Louis	CEO	Acadia Sea Plants
El-Tahan, Mona	President and CEO	CORETEC Incorporated
Ennals, Peter	Vice-President, Academic and Research	Mount Allison University
Gordon, Roger	Dean of Science	University of Prince Edward Island
Jones, Simon	Senior Research Scientist	Aqua Health Ltd.
LaPointe, Michel	Director	Canadian Food Inspection Agency
MacClennan, Edwin	Deputy Director, Centre for International Studies	University College of Cape Breton
MacKay, Robert	Deputy Minister	Technology and Science Secretariat, Nova Scotia
Mills, William	Executive Director	BioNOVA, Nova Scotia Biotechnology and Life Sciences Industry Association
Walker, Dan	President	Marineering Ltd.
Whittick, Judith	President	C-CORE

ANNEX B – PART III

Panel Solicited Stakeholder Input
Part III: Participants in the Panel's Regional Workshops

Ottawa Regional Workshop
Friday 26 May 2000

Co-chairs: Arthur J. Carty and Heather Munroe-Blum, Panel Members

Name	Title	Organization
Alper, Howard	Vice-Rector, Research	University of Ottawa
Campbell, Eddy	Former President	Canadian Mathematical Society
Crocker, Sandra	Vice-Principal, Research	Queen's University
Dorrell, Gordon	Director General, Western Region	AAFC
Everell, Marc Denis	Assistant Deputy Minister	NRCan
Gault, Fred	Director	Statistics Canada
Graham, Mark	Director, Research	Canadian Museum of Nature
Giroux, Robert	President	Association of Universities and Colleges of Canada
Houghton, Derek	President	Sige Microsystems Inc.
Jakubczyk, Z.	President	Optiwave Corporation
Johnson, Peter	President	Association of Canadian Universities for Northern Studies
Linahan, Rowena	General Manager	Salmon Health Consortium
Messier, Leticia	Dean of Studies	Université du Québec à Hull
Moen, Ingar	Director, Science and Technology (Policy)	National Defence
Mosher, Karen	Executive Director	Medical Research Council of Canada
Patry, Gilles	Vice-Rector, Academic	University of Ottawa
Panerella, E.	President and CEO	Advanced Laser & Fusion Technology Inc.
Roots, Fred	Science Advisor Emeritus	Environment Canada
Sells, Bruce H.	Executive Director	Canadian Federation for Biological Societies
Simson, Claudine	Vice-President, Global External Research and Intellectual Property	Nortel Networks
St-Onge, Denis	Chair	Partnership Group for Science and Engineering
Tanner, Peter	Director, Rescarch and Development	Object Technology International Inc.
Torgerson, David	Vice-President, Research and Product Development	Atomic Energy of Canada Limited
Weissenburger, Thierry	Deputy Director, Science and Technology, Trade Commissioner Service	DFAIT

ANNEX B – PART III

Panel Solicited Stakeholder Input
Part III: Participants in the Panel's Regional Workshops

Montréal Regional Workshop
Friday 31 May 2000

Chair: Mr. Luc Martin, Panel Member

Name	Title	Organization
Bélanger, Pierre	Vice-Principal (Research) and Dean	McGill University
Bénié, Goze	Director	Cartel
Berlinguet, Louis	Former President	Conseil de la science et de la technologie
Boillot, Jean-Paul	Chairman and CEO	Servo-Robot Inc.
Bureau, Michel	President	Fonds de la recherche en santé du Québec
DeGranpré, Jean	Chairman	Theratechnologies Inc.
Dillard, Sylvie	Director	Fonds pour la formation de chercheurs et l'aide à la recherche
Delvin, Edgard	Head, Clinical Biochemistry Department	Hôpital Sainte-Justine
Eloy, Philippe	Director, International Cooperation	Ministère de la recherche, de la science et de la technologie
Filion, Louise	Vice-Rector, Research	Université Laval
Gélineau, Guy	Director, North America	Association des universités partiellement ou entièrement de langue française
Guy , Camil	President	Conseil de la science et de la technologie (Québec)
Handfield, My	Adviser, Business Strategy Counsellor	Hydro-Québec
Johnson, William	Executive Director, R&D	Transportation Development Centre
Lightstone, Jack	Provost and Vice-Rector Research	Concordia University
Mercier, Denis	President	Geo-3D Inc.
Milot, Louise	Vice-President, Academic and Research	Université du Québec à Sainte-Foy
Moustapha, Hany	Principal Fellow and Manager	Pratt & Whitney Canada
Nicolas, Jean	Vice-Rector, Research	Université de Sherbrooke
Pimprikar, Milind	President	Centre for Large Space Structures and Systems Inc. and Aeromonitech Inc.
Sékaly, Rafic-Pierre	Program Director	Canadian Network for Vaccines and Immunotherapies of Cancer and Chronic Viro-diseases, Institut de recherches cliniques de Montréal
St-Aubin, Yvan	Professor, Mathematics	Centre de recherche de Montréal
Surprenant, Jacques	Director	Centre de recherche et de développement sur le bovin laitier et le porc
Thompson, Keith	Program Leader	Geomatics for Informed Decisions (Geoide Network)
Thibault, Hélène	Director, Developing Partnerships	Université du Québec à Montréal
Villeneuve, Marc	Director, Advanced Technology	Bombardier Inc
Waterhouse, Alan	Director, Projects	Bell Helicopter Textron
Young, Robert	Vice-President, Medicinal Chemistry	Merck Frosst Centre for Therapeutic Research

Also attending:

René Simard, Panel Chair and ACST Member
Pierre Fortier, ACST Member

ANNEX B – PART III

Panel Solicited Stakeholder Input
Part III: Participants in the Panel's Regional Workshops

Toronto Regional Workshop
Friday 2 June 2000

Co-chairs: Heather Munroe-Blum and Arthur J. Carty, Panel Members

Name	Title	Organization
Allan, Grant	President and CEO	Material and Manufacturing of Ontario
Basque, Richard	Founder and President	Alcyonix Inc.
Bitran, Maurice	Manager	Ontario Challenge Fund
Gerber, Gerhard	Vice-President, Research and International Affairs	McMaster University
Hallett, Ross	Assistant Vice-President, Research	University of Guelph
Holdner, Donald	Vice-President, Technology	Noranda Inc.
Lotimer, Jim	Executive Manager	Lotek Engineering Inc.
Lynch, Gerard	President and CEO	Photonics Research Ontario
Moran, Greg	Provost and Vice-President, Academic	The University of Western Ontario
Petersen, Nills	Acting Vice-President, Research	The University of Western Ontario
Riddle, Chris	Director	Ontario Ministry of Energy, Science and Technology
Sinervo, Pekka	Chair, Department of Physics	University of Toronto
Szabo, Art	Dean of Science	Wilfrid Laurier University
Szumski, Roman	Vice-President, Science and Technology	MDS Inc.
Thompson, John	Dean of Science	University of Waterloo
Vander Voet, Tony	Research Associate	Council of Ontario Universities
Webb, Kathleen	President	CRS Technology Corp.
Whitfield, John	Vice-President, Research and Development	Lakehead University

Also attending:
Stefan Dupré and Jane Pagel, ACST Members

ANNEX B – PART III

Panel Solicited Stakeholder Input
Part III: Participants in the Panel's Regional Workshops

Calgary Regional Workshop
Tuesday 6 June 2000

Chair: Mr. David A. Martin, Panel Member

Name	Title	Organization
Adamowicz, Victor	Program Leader	Sustainable Forest Management
Anderson, John	President and CEO	Alternative Fuel Systems Inc.
Archer, Keith	Associate Vice-President, Research	University of Calgary
Bruton, Len	Vice-President, Research	University of Calgary
Cookson, Peter	Associate Vice-President, Research and Institutional Studies	Athabasca University
Foldvari, Marianna	President	Pharmaderm Laboratories Ltd.
Humble, Ronald	Senior Policy Advisor	Industry Trade and Mines, Manitoba
Kunik, Harold	Chief Financial Officer	CLINICARE Corporation
Moran, Stephen	Director, Issues Management Policy and Economic Analysis	Ministry of Economic Development, Alberta
Peterson, Hans	President	WateResearch Corp.
Pederson, Roger	Vice-President and Director, Edmonton Operations	TELUS Communications Inc.
Pelzer, Cam	Director, Policy and Strategic Planning Branch	Saskatchewan Economic and Cooperative Development
Smith, William	Regional Director, Prairies	IRAP/NRC
Sutherland, Lynn	Director of Programs	Alberta Informatics Circle of Research Excellence
Wellbrock, Garry	President and Chairman of the Board	Saskatchewan Wheat Pool
Woods, Donald	Scientific Director	Canadian Bacterial Diseases Network
Woods, Roger	Industrial Technology Advisor	IRAP/NRC
Zaparniuk, Lori	Technology Development Officer	Ministry of Innovation and Science, Alberta

ANNEX B – PART III

Panel Solicited Stakeholder Input

Part III: Participants in the Panel's Regional Workshops

Vancouver Regional Workshop

Wednesday 7 June 2000

Co-chairs: Garrett Lambert and William Saywell, Panel Members

Name	Title	Organization
Astbury, Alan	Director	TRIUMF
Bressler, Bernie	Vice-President, Research	Vancouver Hospital and Health Sciences Centre
Cairns, Max	Vice-President	Science Council of British Columbia
Calvert, Tom	Vice-President, Research	Technical University of British Columbia
Chow, Suezone	Vice-President, R&D	Canfor Corporation
Culbertson, Stuart	Deputy Minister	Information, Science and Technology Agency
Daniels, Terry	President	Daniels Electronics Ltd.
Fung, David	President	ACDEG International Inc.
Maynard, Allan	Managing Director	Analytical Service Laboratories Ltd.
Nelson, Chris	Assistant Deputy Minister	B.C. Trade and Investment Office
Rix, Don	Chairman	MDS Metro Laboratory Services
Samarasekera, Indira	Vice-President, Research	University of British Columbia
Schulz, Harry	Director, Business Operations	St. Boniface General Hospital Research Centre
Slaymaker, Olav	Director, Faculty of Graduate Studies	University of British Columbia
Stephenson, Joanne	Vice-President, Business Development	Response Biomedical Corporation
Stewart, John	Former Dean of Agriculture	University of Saskatchewan
Taylor, Martin	Vice-President, Research	University of Victoria
Williams, Craig	Executive Vice-President	Nicholson Industries

ANNEX C

Inventory of Canada's Federal Participation and Investment in International S&T

		Federal Investment in 1999–2000
Part I	**Canada's Participation and Investment in Major International Programs/Projects, Facilities and Organizations Directly Related to the Performance of S&T**	
	Section A: Major international S&T programs and projects *excluding* projects conducted at major international facilities	$ 34 043 164
	Section B: Contributions to major international S&T facilities (Section B1), and projects conducted at the facilities (Section B2)	$ 21 644 100
	Section C: Participation in major international S&T organizations	$ 13 109 282
	TOTAL	**$ 68 796 546**

Canada is also a member of a number of international organizations and signatory to a number of international conventions and treaties, for which the performance of S&T is not the main objective, but which have an undetermined S&T element. The Panel felt that an inventory of those organizations would be useful; they are listed in Part II.

Part II Participation in Major International Organizations, Conventions and Treaties with an Undetermined S&T Component

Section A: United Nations organizations

Section B: Other international organizations

Section C: Conventions and treaties

Note : This inventory is not exhaustive and is based on information obtained from SBDAs and DFAIT. It does not include the activities of CIDA or IDRC. Although both agencies are active in international S&T, the Panel felt that their activities should not be included, since they are primarily in support of capacity building in developing countries, not in the performance of S&T.

ANNEX C — PART I

Inventory of Canada's Federal Participation and Investment in International S&T*

Part I: Participation and Investment in Major International Programs/Projects, Facilities and Organizations Directly Related to the Performance of S&T

Section A lists Canada's federal participation and investment in major international S&T programs and projects. Section B indicates Canada's federal participation and investment in major international S&T facilities, including projects conducted at the facilities. Section C captures Canada's federal participation and investment in major international S&T organizations.

Program/Project Name	**Program/Project Description**	**Contributing Department or Agency**	**Amount $**	
			1998–99	**1999–2000**
Section A: Major international S&T programs and projects, *excluding* projects conducted at major international facilities *(listed in Section B)*				
Advanced Research in Telecommunications Systems (ARTES) Program	*This is a program of the European Space Agency (ESA). See Section C for information on the ESA.* ARTES is the ESA's main telecommunications initiative. ARTES 1 through 9 deal primarily with the identification, development, testing, advancement and commercialization of emerging telecommunications technologies.	CSA	4 546 332	**7 825 637**
Sea Lamprey Control Program	*This is a program of the Great Lakes Fishery Commission. See Section C for information on the Great Lakes Fishery Commission.* Sea lamprey control is a critical fishery management action to achieve a 50% reduction in parasitic-phase sea lamprey abundance by 2000, and a 90% reduction in parasitic-phase sea lamprey abundance by 2010. Sea lampreys are aquatic vertebrates native to the Atlantic Ocean that can live in both salt and fresh waters. Sea lampreys, now found in all the Great Lakes, attach to fish with a sucking disk and sharp teeth and feed on body fluids, often scarring and killing the host fish. The Great Lakes Fishery Commission was created as a result of the 1995 ratification of the US-Canada Convention on Great Lakes Fisheries whose objectives were to facilitate coordinated binational fisheries management.	DFO	5 055 414	**5 512 688**
Polar Orbit Earth Observation Mission Programme (POEM / ENVISAT)	*This is a program of the ESA. See Section C for information on the ESA.* The ESA Earth Observation Programmes focus on five fundamental objectives: studying and monitoring the Earth's environment on various scales, from local through regional to global; monitoring and managing the Earth's resources, both renewable and non-renewable; continuing and improving services provided to the worldwide operational meteorological community; contributing to the understanding of the structure and dynamics of the Earth's crust and interior; initiating and consolidating services for application communities with emerging needs for Earth observation data from space. In June 2001, the ESA will launch Envisat-1, an advanced polar-orbiting Earth observation satellite that will provide measurements of the atmosphere, ocean, land and ice over a five-year period.	CSA	6 689 708	**5 441 668**

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ANNEX C — PART I

Inventory of Canada's Federal Participation and Investment in International S&T*

Part I: Participation and Investment in Major International Programs/Projects, Facilities and Organizations Directly Related to the Performance of S&T

Program/Project Name	Program/Project Description	Contributing Department or Agency	Amount $	
			1998–99	1999–2000
Section A: Major international S&T programs and projects, *excluding* projects conducted at major international facilities *(listed in Section B)*				
Joint Strike Fighter (JSF) Program	The Joint Strike Fighter (JSF) Program is the U.S. Department of Defense's focal point for defining affordable next-generation strike aircraft weapon systems for the U.S. Navy, Air Force, Marines and their allies. The focus of the JSF Program is affordability, i.e., reducing the cost of development, production and ownership of the JSF family of aircraft. Canada, along with Denmark, Norway, the Netherlands and Italy participate as cooperative partners. The United Kingdom has been a Full Collaborative Partner in the program since 1995.	DND	6 450 000	**4 500 000**
Earth Observation Preparatory Program (EOPP)	*This is a program of the ESA. See Section C for information on the ESA.* The EOPP is a transitional program leading to the Earth Observation Envelope Programme, better known as the Living Planet Programme. The following are the two main components of the program: 1. The Earth Explorer Component, which includes the definition, development, launch and operations of Earth Explorer (Core and Opportunity) missions. The missions will cover the science of Earth's interior, oceans, atmosphere, cryosphere and land surface. 2. The Development and Exploitation Component, which includes preparatory activities and instrument pre-development for Earth Explorer and Earth Watch; definition of Earth Watch-type missions and the preparation of dedicated program proposals for optional Earth Watch-type programs; and mission exploitation/market development.	CSA	1 788 020	**1 680 480**
Ocean Drilling Program (ODP)	The ODP is an international partnership of scientists and research institutions organized to explore the evolution and structure of Earth. The ODP provides researchers around the world with access to a vast repository of geological and environmental information recorded far below the ocean surface in seafloor sediments and rocks. The study of ODP data leads to a better understanding of Earth's past, present and future. More than 20 countries are currently represented in the ODP.	NRCan NSERC	783 238 775 000	635 205 975 000
		TOTAL	1 558 238	**1 610 000**
European Remote Sensing Satellite (ERS-2) Program	*This is a program of the ESA. See Section C for information on the ESA.* The information provided by ERS has had a profound impact on the understanding of oceans and polar ice caps and an immediate benefit in many other areas, such as ice-cover surveys, pollution and natural disaster monitoring, ship routing, and offshore exploration, all of which are of prime importance for Canada.	CSA	1 938 286	**1 514 122**

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Program/Project Name	Program/Project Description	Contributing Department or Agency	Amount $	
			1998–99	1999–2000
Section A: Major international S&T programs and projects, *excluding* projects conducted at major international facilities *(listed in Section B)*				
Canada–Israel Industrial R&D Foundation (CIIRDF)	CIIRDF was established to promote collaborative R&D between firms in Canada and Israel, by providing information to firms in both countries on R&D partnering potential and supporting binational industrial R&D initiatives through the contribution of up to 50% of the R&D costs. This contribution is repayable in the event that commercial revenues arise from the project.	DFAIT	500 000	500 000
		IC	500 000	500 000
		TOTAL	1 000 000	**1 000 000**
Past Global Changes (PAGES)	*This is a program of the International Geosphere-Biosphere Programme (IGBP), a program of the International Union for Science (ICSU).* PAGES is the IGBP Core Project charged with providing a quantitative understanding of the Earth's past environment and defining the envelope of natural environmental variability within which anthropogenic impact on the Earth's biosphere, geosphere and atmosphere can be assessed. PAGES seeks to obtain and interpret a variety of paleoclimatic records to provide the data essential for the validation of predictive climatic models. PAGES seeks the integration and intercomparison of ice, ocean and terrestrial paleorecords, and encourages the creation of consistent analytical and database methodologies within the paleosciences.	NSERC	854 212	**907 600**
Global Ocean Ecosystem Dynamics (GLOBEC)	*This is a program of the Scientific Committee on Oceanic Research (SCOR), a committee of the International Union for Science (ICSU). See Part III for information on ICSU.* The main goal of GLOBEC is to advance the understanding of the structure and functioning of the global ocean ecosystem, its major subsystems, and its response to physical forcing, in order to develop the capability to forecast the marine upper trophic system response to scenarios of global change.	NSERC	835 000	**708 500**
Global Energy and Water Cycle Experiment (GEWEX)	*This is a program of the World Climate Research Program (WCRP).* GEWEX was initiated in 1988 by the WCRP to observe and model the hydrologic cycle and energy fluxes in the atmosphere, at the land surface, and in the upper oceans. GEWEX is an integrated program of research, observations, and science activities that will ultimately lead to the prediction of global and regional climate change.	NSERC	725 611	**666 828**
Canadian participation in the Super Dual Auroral Radar Network (SuperDARN)	SuperDARN is a network of high-frequency radars used to study the Earth's ionosphere. NSERC's contribution includes a payment to access the network.	NSERC	0	**657 169**

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ANNEX C — PART I

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Part I: Participation and Investment in Major International Programs/Projects, Facilities and Organizations Directly Related to the Performance of S&T

Program/Project Name	Program/Project Description	Contributing Department or Agency	Amount $	
			1998–99	1999–2000
Section A: Major international S&T programs and projects, *excluding* projects conducted at major international facilities *(listed in Section B)*				
Human Frontier Science Program (HFSP)	The aim of the HFSP is to support international cooperation in scientific research in the neurosciences and, in the broadest sense, molecular biology. This is achieved through programs that encourage interaction between scientists in different countries. Emphasis is placed on intercontinental collaborations involving scientists in the early stages of their careers. The current HFSP members are the G7 nations, Switzerland and the non-G7 members of the European Union, which are represented by the European Commission.	MRC NRC	360 000 290 000	360 000 290 000
	Note: NRC's contribution for both years is US$200K; thus, the figure provided in Canadian dollars is an approximate value.	*TOTAL*	650 000	**650 000**
Global Environment Monitoring System (GEMS) / Water	*This is a program of the UNEP. See Part II, Section A for information on the UNEP* This is a joint UNEP/WHO program on global water quality conducted in partnership with numerous organizations. The GEMS/Water program is a multi-faceted water science program oriented toward understanding freshwater quality issues throughout the world. The program contributes significantly toward a global appreciation of current water quality status and trends while promoting sustainable freshwater quality management. GEMS/Water activities include the maintenance of a global database with information from approximately 60 countries; participation in international data programs and monitoring; data and information sharing; participation in global and regional assessments; capacity building; and the provision of advice to governments and international agencies. DFAIT contributes to a Trust Fund for this program and the National Water Research Institute at Environment Canada to manage Canada's participation. GEMS/Water has 66 participating countries.	DFAIT EC	150 000 350 000	150 000 350 000
		TOTAL	500 000	**500 000**

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ANNEX C — PART I

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Program/Project Name	Program/Project Description	Contributing Department or Agency	Amount $	
			1998–99	1999–2000
Section A: Major International S&T programs and projects, *excluding* projects conducted at major international facilities *(listed in Section B)*				
Optical Spectrograph and InfraRed Imaging System (OSIRIS) Project	The project involves the design and construction of an optical spectrograph called OSIRIS 2 for the Odin Satellite, which is scheduled for launch in November 2000. OSIRIS 2 has the purpose of detecting aerosol layers and measuring abundances of O_3, NO_2, OClO, and NO with increased sensitivity in the wavelength region of the spectrograph. In 1994, the Swedish National Space Board (SNSB) gave the final go-ahead for the development and launch in 1998 of Odin. Odin is a dual-mission small satellite for research of both astronomical and atmospheric topics. The astronomical objectives are related primarily to star formation processes in the interstellar medium, and the atmospheric research (aeronomy) objectives relate primarily to processes behind ozone layer depletion and the geographical extent of the disturbance. The Odin project is carried out cooperatively by scientists and space agencies in Sweden, Canada, Finland and France. OSIRIS 2 is one of the instruments for Odin.	NSERC	331 500	**320 000**
Data Relay and Technology Mission Program (DRTM) and ARTEMIS	*This is a program of the ESA. See Section C for information on the ESA.* The DRTM involves the launch of the ARTEMIS satellite and two Data Relay System (DRS) satellites. ARTEMIS is an advanced satellite for testing and operating new telecommunications techniques and services. The ARTEMIS project also includes the design, procurement, implementation and system validation of additional ground segment facilities needed to support routine operations. The purpose of the ARTEMIS and DRS satellites is to provide an operating system which would be used to control and monitor a variety of manned and unmanned spacecraft in an autonomous way.	CSA	211 511	**275 072**
Measurements of Pollution in the Troposphere (MOPITT)	MOPITT is an instrument to be mounted on the atmospheric satellite called Terra, to study the chemicals our atmosphere is made of. The MOPITT Science Team is an international group with members in Canada, the United States and the United Kingdom. This group oversees the development of the MOPITT instrument, the data processing software, and the validation of the data products, and will have significant involvement in the application of the data to atmospheric chemistry research. The goal of the MOPITT experiment is to enhance our knowledge of the lower atmosphere system, in particular how it interacts with the surface/ocean/biomass systems. The particular focus is the distribution, transport, sources and sinks of carbon monoxide and methane in the troposphere.	NSERC	273 400	**273 400**
TOTAL spending on major International S&T programs and projects (Section A)			$ 33 407 232	**$ 34 043 164**

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ANNEX C — PART I

Inventory of Canada's Federal Participation and Investment in International S&T*

Part I: Participation and Investment in Major International Programs/Projects, Facilities and Organizations Directly Related to the Performance of S&T

Facility Name	Description of facility or project at facility	Contributing Department or Agency	Amount $	
			1998–99	1999–2000
Section B: Contributions to major international S&T facilities (Section B1), and projects conducted at the facilities (Section B2)				
Section B1 : Contributions to major international S&T facilities				
European Organization for Nuclear Research (CERN)	CERN provides state-of-the-art accelerators in which tiny particles are accelerated to a fraction less than the speed of light and detectors make the particles visible. Canada secured access to CERN's facilities through the commitment of $30M over the period 1995–2000 to the Large Hadron Collider (LHC). NRC administers the federal contribution to TRIUMF, which acts as Canada's main connection to CERN. TRIUMF is the focal point for Canada's participation in CERN. CERN has 20 member states in Europe which provide financial contributions in proportion to their net national incomes. The 34 non-member states, including Canada, are permitted access to the facilities through reciprocal agreements that allow free access to experimenters, regardless of their country of origin. However, the physicists and their funding agencies from both member and non-member states are responsible for the financing, construction and operation of the experiments on which they collaborate.	TRIUMF/NRC	6 000 000	**6 000 000**
Canada–France–Hawaii Telescope (CFHT)	CFHT is a 3.6-metre optical/infrared telescope located on Mount Mauna Kea in Hawaii. It is used to gather data about the early universe, its geometry, the nature of dark matter, star clusters, and galactic structure (including the structure of the Milky Way galaxy to which the solar system belongs). A new infrared camera to be commissioned, called the CFHT-IR, will be capable of direct imaging and serving as a spectroscopic detector behind the Optionally Stabilized Imager and Spectrometer (OSIS). It will provide new capabilities for the study of star formation regions in the Milky Way and beyond. The technological advances embodied in the CFHT-IR, and similar systems elsewhere, are exposing the optically obscured sites where new stars and their planetary systems are being formed today. The countries involved are Canada, France and the United States (Hawaii). NRC, the Centre national de la recherche scientifique of France and the University of Hawaii are responsible for funding and managing the CFHT.	NRC	3 253 000	**3 253 000**
James Clerk Maxwell Telescope (JCMT)	The JCMT is a telescope designed specifically to operate in the submillimetre wavelength region of the spectrum. The JCMT is used to study our Solar System, interstellar dust and gas, and distant galaxies. It is situated close to the summit of Mauna Kea in Hawaii. The countries involved are Canada, the Netherlands and the United Kingdom. NRC, the Netherlands Organization for Scientific Research, and the Particle Physics and Astronomy Research Council of the United Kingdom are the national organizations responsible for funding and managing the JCMT.	NRC	1 151 000	**1 257 000**

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Facility Name	Description of facility or project at facility	Contributing Department or Agency	Amount $	
			1998–99	1999–2000
Section B: Contributions to major international S&T facilities (Section B1), and projects conducted at the facilities (Section B2)				
Section B1 : Contributions to major international S&T facilities				
GEMINI Telescopes	The GEMINI telescopes under construction are twin 8.1-metre astronomical telescopes utilizing new technology to produce some of the sharpest views of the universe ever. One telescope will be located atop Hawaii's Mauna Kea and the other atop Chile's Cerro Pachón. Together, they will provide complete unobstructed coverage of both the Northern and Southern skies. The countries involved are the United States, Canada, the United Kingdom, Brazil, Argentina, Australia and Chile. NRC is responsible for Canada's involvement in the GEMINI telescopes.	NRC	1 200 000	**1 200 000**
TOTAL Contributions made to major international S&T facilities (Section B1)			$ 11 604 000	**$ 11 710 000**

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ANNEX C — PART I

Inventory of Canada's Federal Participation and Investment in International S&T*

Part I: Participation and Investment in Major International Programs/Projects, Facilities and Organizations Directly Related to the Performance of S&T

Project Name/ Facility Name	**Description of Facility**	**Contributing Department or Agency**	**Amount $**	
			1998–99	**1999–2000**
Section B: Major international S&T facilities, *including* projects conducted at the facilities				
Section B2: Contributions to projects at the facilities				
ATLAS /CERN	ATLAS, a study of proton-proton interactions at the Large Hadron Collider (LHC), is designed to improve fundamental understanding of matter and forces. A prime physics goal of ATLAS is to understand the nature of mass.	NSERC	3 014 500	4 531 000
		NRC	1 104 376	1 044 581
		TOTAL	4 118 876	**5 575 581**
Omni-purpose Apparatus (OPAL)/CERN	OPAL is one of the major particle physics experiments at CERN. It studies particles and their interactions by collecting and analysing electron-positron collision events at the Large Electron-Positron (LEP) collider. *Note: NRC's contribution for both years was provided in Swiss francs; thus, the figure provided in Canadian dollars is an approximate value.*	NSERC	1 656 000	1 474 000
		NRC	27 645	27 729
		TOTAL	1 683 645	**1 501 729**
ZEUS/DESY	The ZEUS experiment is a high-energy physics experiment studying interactions between electrons and protons, conducted at the Deutches Elektronen-Synchrotron (DESY) situated in Hamburg, Germany. ZEUS involves an international collaboration of about 450 scientists from more than 50 institutions in 12 countries. The experiment began operation in April 1992.	NSERC	965 000	**867 000**
B and B-Bar (BaBar) experiment / Stanford Linear Accelerator Centre (SLAC)	The B and B-Bar experiment is conducted at the BaBar detector. The detector records the particles produced when the B and the B-Bar particles decay. The goal is to use differences in decay to decipher the tiny differences in the laws of physics for antimatter compared with the laws for matter. It is hoped that the experiment would help understanding why the universe contains matter but very little antimatter.	NSERC	437 500	**691 500**
Rare Kaon Decay Experiment / Brookhaven National Lab (BNL)	The experiment led to the discovery of an unusual breakdown of an unstable subatomic particle, the kaon, and may confirm the aspects of the current theory on the effects of the universe's most elemental forces on the ultimate building blocks of matter. The experiment involves a team of 50 researchers from Brookhaven, Canada's TRIUMF laboratory and University of Alberta, Japan's KEK laboratory and Osaka University, and Princeton University.	NSERC	605 000	**583 000**

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Project Name/ Facility Name	Description of Facility	Contributing Department or Agency	Amount $	
			1998–99	1999–2000
Section B: Major International S&T facilities, *including* projects conducted at the facilities				
Section B2: Contributions to projects at the facilities				
HERMES/DESY	HERMES investigates the quark-gluon structure of matter, and studies the spin structure of the nucleon. The first HERMES run started in 1995 and will end in September 2000. HERMES Run 2 will take place during 2001–06. HERMES is conducted at the Deutches Elektronen-Synchrotron (DESY) situated in Hamburg, Germany.	NSERC	431 000	**480 290**
Experiment at the Collider Detector at Fermilab (CDF)	The CDF experimental collaboration is committed to studying high-energy particle collisions. The goal is to discover the identity and properties of the particles that make up the universe and to understand the forces and interactions between these particles.	NSERC	283 000	**235 000**
TOTAL spending on projects conducted at the facilities (Section B2)			8 524 021	**$ 9 934 100**
TOTAL spending on major international S&T facilities and projects conducted at the facilities (Sections B1 and B2)			$ 20 128 021	**$ 21 644 100**

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Inventory of Canada's Federal Participation and Investment in International S&T*

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Organization Name	Description of Organization	Contributing Department or Agency	Amount $	
			1998–99	1999–2000
Section C: Participation in major international S&T organizations				
European Space Agency (ESA)	The ESA has conducted a number of programs in space exploration that have led to the development of advanced technologies. The ESA was created 25 years ago and includes 14 European countries. Canada is the only non-European country to be closely associated with the EAS. Canada participates in a number of ESA programs. The objectives of Canada's cooperation with the ESA fall into three categories: 1) From a policy point of view, the focus is on the diversification and reinforcement of Canada's posture as an international space partner and on fostering closer collaboration between Canada and Europe in S&T research. 2) In terms of programming, Canada seeks to develop and demonstrate advanced systems and technologies. 3) Canada also seeks to support the competitiveness of Canadian industry, through alliances with European firms, and to foster the two-way transfer of technologies between Europe and Canada.	CSA	5 714 570	**6 335 349**
International Agency for Research on Cancer (IARC)	IARC's mission is to coordinate and conduct research on the causes of human cancer, the mechanisms of carcinogenesis, and to develop scientific strategies for cancer control. The Agency is involved in both epidemiological and laboratory research and disseminates scientific information through publications, meetings, courses and fellowships. IARC is part of the World Health Organization and has 18 participating states.	MRC, HC	200 000 1 400 000	200 000 1 400 000
		TOTAL	1 600 000	**1 600 000**
International Pacific Halibut Commission (IPHC)	The mandate of the IPHC is to study and preserve the stocks of Pacific halibut within the territorial waters of Canada and the United States, the two signatory countries. The Commission, originally called the International Fisheries Commission, was established in 1923.	DFO	1 184 870	**1 173 960**
Pacific Salmon Commission (PSC)	The PSC has two fundamental roles: 1) to conserve the Pacific Salmon in order to achieve optimum production; and 2) to divide the harvests so that each country reaps the benefits of its investment in salmon management. The PSC is the body formed by the governments of Canada and the United States to implement the Pacific Salmon Treaty. This Commission gives both countries a forum through which to resolve salmon management problems.	DFO	800 000	**800 000**
Bureau international des poids et mesures (BIPM) [International Bureau of Weights and Measures]	The task of the BIPM is to ensure worldwide uniformity of measurements and their traceability to the International System of Units. The BIPM carries out measurement-related research. It takes part in and organizes international comparisons of national measurement standards. NRC is Canada's representative in the BIPM. The BIPM has 48 member states.	NRC	568 000	**558 000**

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			1998–99	**1999–2000**
Section C: Participation in major international S&T organizations				
International Council for Science / International Council of Scientific Unions (ICSU)	ICSU initiates and coordinates international interdisciplinary programs and creates interdisciplinary bodies that undertake activities and research programs of interest to its members. A number of bodies set up within ICSU also address matters of common concern to all scientists, such as capacity building in science, environment and development and the free conduct of science. ICSU is a non-governmental scientific organization involving 26 International Scientific Union Members and 98 National Scientific Members (mostly national academies of sciences). NRC is Canada's member to ICSU and to most of its member bodies.	NRC	500 000	**500 000**
Northwest Atlantic Fisheries Organization (NAFO)	NAFO's primary objective is to contribute through consultation and cooperation to the optimum utilization, rational management and conservation of the fishery resources of the Convention Area and, to this end, to promote scientific research and cooperation among the contracting parties. There are 18 contracting parties in NAFO.	DFO	364 446	**425 958**
Great Lakes Fishery Commission	The Commission has two major responsibilities: 1) to develop coordinated programs of research on the Great Lakes and, on the basis of the findings, to recommend measures that will permit the maximum sustained productivity of fish stocks of common concern; and 2) to formulate and implement a program to eradicate or minimize sea lamprey populations in the Great Lakes. The Great Lakes Fishery Commission was created as a result of the 1955 ratification of the Convention on Great Lakes Fisheries whose role was to facilitate coordinated fisheries management, by the governments of Canada and the United States.	DFO	438 819	**424 431**
Commonwealth Agricultural Bureaux International (CABI)	The mission of CABI is to help improve human welfare worldwide through the dissemination, application and generation of scientific knowledge in support of sustainable development, with an emphasis on agriculture, forestry, human health and the management of natural resources, and with particular attention to the needs of developing countries. CABI currently has 40 member countries.	AAFC	317 000	**400 000**
International Space University (ISU)	The ISU's objective is to train and educate professionals in the international space arena. Interdisciplinary diversity is integrated into a coherent, structured whole in an international, multicultural environment. ISU provides scholarships for Canadian students.	CSA	175 000	175 000
		MRC	40 000	40 000
		TOTAL	215 000	**215 000**

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ANNEX C — PART I

Inventory of Canada's Federal Participation and Investment in International S&T*

Part I: Participation and Investment in Major International Programs/Projects, Facilities and Organizations Directly Related to the Performance of S&T

Organization Name	Description of Organization	Contributing Department or Agency	Amount $	
			1998–99	1999–2000
Section C: Participation in major international S&T organizations				
International Council for the Exploration of the Sea (ICES)	ICES is an intergovernmental organization concerned with marine and fisheries science. Oceanographic investigations form integral parts of the ICES program of multidisciplinary work aimed at understanding the features and dynamics of water masses and their ecological processes. In many instances, emphasis is placed on the influence of changes in hydrography (e.g. temperature and salinity) and current flow on the distribution, abundance, and population dynamics of finned fish and shellfish stocks. These investigations are also relevant to marine pollution studies, because physical oceanographic conditions affect the distribution and transport of contaminants in the marine environment. ICES promotes the development and calibration of oceanographic equipment and the maintenance of appropriate standards of quality and comparability of oceanographic data.	DFO	191 940	**198 704**
Inter-American Institute for Global Change Research (IAI)	The goal of the IAI is to augment the scientific capacity of the Americas and to provide information in a useful and timely manner to policy makers. Its primary objective is to encourage research beyond the scope of national programs, by advancing comparative and focussed studies based on scientific issues important to the Americas as a whole. The IAI is an intergovernmental organization supported by 18 countries in the Americas.	DFAIT	73 300	73 300
		EC	73 300	73 300
		TOTAL	146 600	**146 600**
North Pacific Anadromous Fish Commission (NPAFC)	NPAFC's objective is to promote the conservation of anadromous stocks in the North Pacific Ocean. NPAFC was established by Canada, Japan, the Russian Federation and the United States.	DFO	135 000	**135 000**
North Pacific Marine Science Organization	The purposes of the Organization are as follows: 1) to promote and coordinate marine research in the northern North Pacific and adjacent seas especially north of 30°N; 2) to advance scientific knowledge about the ocean environment, global weather and climate change, living resources and their ecosystems, and the impacts of human activities; and 3) to promote the collection and rapid exchange of scientific information on these issues. Current members of the Organization include Canada, People's Republic of China, Japan, Republic of Korea, Russian Federation and the United States.	DFO	86 000	**88 600**
North Atlantic Salmon Conservation Organization (NASCO)	NASCO is an international body with the objective of contributing through consultation and cooperation to the conservation, restoration, enhancement and rational management of salmon stocks, taking into account the best scientific evidence available to it. Contracting parties include Canada, Denmark (in respect of the Faroe Islands and Greenland), European Union, Iceland, Norway, Russian Federation and the United States.	DFO	92 232	**68 818**

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* This list is not exhaustive and is based on information obtained from SBDAs and DFAIT.

Notes:
1) Sections A and B include programs and projects that involve researchers from more than one organization.
2) In all sections, lists are in decreasing order of funding amounts for fiscal year 1999–2000. Only activities requiring funding of more than $10 000 in 1999–2000 are included.
3) As of June 2000, the Medical Research Council of Canada has been replaced by the Canadian Institutes of Health Research.
4) Refer to Annex F for an explanation of the acronyms used for Contributing Department or Agency.

ANNEX C — PART I

Inventory of Canada's Federal Participation and Investment in International S&T*

Part I: Participation and Investment in Major International Programs/Projects, Facilities and Organizations Directly Related to the Performance of S&T

Organization Name	Description of Organization	Contributing Department or Agency	Amount $	
			1998–99	1999–2000
Section C: Participation in major international S&T organizations				
Organisation internationale de métrologie légale (OIML)	The OIML was established in 1955 to promote the global harmonization of legal metrology procedures. Since that time, the OIML has developed a worldwide technical structure that provides its members with metrological guidelines for the elaboration of national and regional requirements concerning the manufacture and use of measuring instruments for legal metrology applications. Industry Canada is Canada's representative to the OIML. The OIML has approximately 55 members.	IC	32 836	**38 862**
TOTAL spending on major international S&T organizations (Section C)			$ 12 387 313	**$ 13 109 282**
TOTAL investment in major international programs/projects, facilities and organizations directly related to the performance of S&T (Sections A, B and C)			$ 65 922 566	**$ 68 796 546**

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* This list is not exhaustive and is based on information obtained from SBDAs and DFAIT.

Notes:
1) Sections A and B include programs and projects that involve researchers from more than one organization.
2) In all sections, lists are in decreasing order of funding amounts for fiscal year 1999–2000. Only activities requiring funding of more than $10 000 in 1999–2000 are included.
3) As of June 2000, the Medical Research Council of Canada has been replaced by the Canadian Institutes of Health Research.
4) Refer to Annex F for an explanation of the acronyms used for Contributing Department or Agency.

ANNEX C — PART II

Inventory of Canada's Federal Participation and Investment in International S&T*

Part II: Participation in Major International Organizations, Conventions and Treaties with an Undetermined S&T Component

Section A lists Canada's federal participation in United Nations organizations. Section B includes Canada's federal participation in other international organizations. Section C captures Canada's federal participation in conventions and treaties.

Organization Name	Description of Organization	Contributing Department or Agency
Section A: United Nations organizations		
Food and Agricultural Organization (FAO)	The FAO's specific priority is to encourage sustainable agriculture and rural development through a long-term strategy for the conservation and management of natural resources. It aims to meet the needs of both present and future generations through programs that do not degrade the environment and that are technically appropriate, economically viable and socially acceptable. FAO is an autonomous agency within the UN system with 180 member nations.	DFAIT
International Atomic Energy Agency (IAEA)	The IAEA assists in planning for and using nuclear science and technology for various peaceful purposes; facilitates the transfer of such technology and knowledge in a sustainable manner; develops and promotes nuclear safety standards; and, through its inspection system, contributes to the protection of human health and the environment against ionizing radiation. The IAEA is an independent intergovernmental, science- and technology-based organization in the UN family that serves as the global focal point for nuclear cooperation. The IAEA has 130 member states.	DFAIT
International Commission for the Conservation of Atlantic Tunas (ICCAT)	The ICCAT is an intergovernmental fishery organization responsible for the conservation of tunas and tuna-like species in the Atlantic Ocean and its adjacent seas. The Commission 1) compiles fishery statistics from its members and from all entities fishing for these species in the Atlantic Ocean; 2) coordinates research, including stock assessment, on behalf of its members; 3) develops scientific-based management advice; 4) provides a mechanism for contracting parties to agree on management measures; and 5) produces relevant publications. Currently, there are 28 contracting parties to the ICCAT.	DFO
United Nations Educational, Scientific and Cultural Organization (UNESCO)	The main objective of UNESCO is to contribute to peace and security in the world by promoting collaboration among nations through education, science, culture and communication. In addition, UNESCO seeks to further universal respect for justice, the rule of law, and the human rights and fundamental freedoms that are affirmed for the peoples of the world, without distinction of race, sex, language or religion, by the Charter of the United Nations. UNESCO has 188 member states.	DFAIT
United Nations Environment Programme (UNEP)	UNEP's mandate is to analyze and assess the state of the global environment; further the development of international environmental law; advance the implementation of agreed international norms and policies; monitor and foster compliance in these areas; promote greater awareness and facilitate effective cooperation in the implementation of the international environmental agenda; and provide policy advice in key areas of institution building. DFAIT contributes to UNEP through the Voluntary Fund, which provides additional financing for UNEP programs.	DFAIT

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ANNEX C — PART II

Inventory of Canada's Federal Participation and Investment in International S&T*

Part II: Participation in Major International Organizations, Conventions and Treaties with an Undetermined S&T Component

Organization Name	Description of Organization	Contributing Department or Agency
Section A: United Nations organizations		
United Nations University - International Network on Water, Environment and Health (UNU-INWEH)	Canada provides the core funding to this interdisciplinary and global network of water pollution and management experts, non-governmental organizations, academic institutions, UN and other multilateral bodies, and private sector companies. The purpose of the UNU-INWEH is to strengthen water management capacity, particularly in developing countries, and to provide on-the-ground project support.	*EC*
World Health Organization (WHO)	WHO's objective is the attainment by all peoples of the highest possible level of health. Health, as defined in the WHO Constitution, is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity. DFAIT covers the cost of Canada's membership in WHO. Health Canada's contribution is provided to undertake research and program activities to help reduce the use of tobacco products. WHO has 191 member states.	DFAIT HC
World Meteorological Organization (WMO)	The WMO coordinates global scientific activity to allow increasingly prompt and accurate weather information and other services for public, private and commercial use, including international airline and shipping industries. The WMO's activities in weather prediction, air pollution research, climate change-related activities, ozone layer depletion studies and tropical storm forecasting, contribute to the safety of life and property, the socio-economic development of nations, and the protection of the environment. The WMO has more than 70 member states.	EC

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ANNEX C — PART II

Inventory of Canada's Federal Participation and Investment in International S&T*

Part II: Participation in Major International Organizations, Conventions and Treaties with an Undetermined S&T Component

Organization Name	Description of Organization	Contributing Department or Agency
Section B: Other International organizations		
Advisory Committee on the Protection of the Sea (ACOPS)	ACOPS' mandate is to encourage the prevention of marine pollution and to promote and conduct research into its causes and effects, through a global program and a series of regional programs developed in accordance with the UNEP Global Programme of Action for the Protection of the Marine Environment from Land-based Activities. Canada's contribution is directed largely toward the Regional Arctic Programme. ACOPS' recent and ongoing programs are carried out with the political and financial support of 18 governments and a number of international, intergovernmental, public and private organizations.	DFAIT
Agence de la Francophonie *(formerly Agence de Coopération Culturelle et Technique)*	The Agence de la Francophonie's activities are based on five major areas: knowledge and progress, culture and communication, economy and development, freedom and democracy ,and the promotion of the French language in the world. As part of its activities, the Agence de la Francophonie provides a forum for cooperation and discussion of national S&T policies on an ad hoc basis, e.g., when a need is expressed by its member countries. The Agence de la Francophonie has 51 member states and governments.	DFAIT
Asia-Pacific Economic Cooperation (APEC)	APEC's goal is to advance Asia-Pacific economic dynamism and sense of community. Begun as an informal dialogue group, APEC has since become the primary regional vehicle for promoting open trade and practical economic cooperation. APEC's Industrial Science and Technology Working Group (IST WG) is one of ten working groups that promote economic and technical cooperation among the APEC member economies. Its vision for the 21st century is of "a dynamic and prosperous Asia-Pacific region, built on the development and application of industrial science and technology, which improves quality of life while safeguarding the natural environment." DFAIT is the lead department for Canada's overall participation in APEC. Working in cooperation with DFAIT, Industry Canada is the lead department for Canada's participation in APEC's IST WG.	DFAIT
Inter-American Institute for Cooperation on Agriculture (IICA)	IICA's purposes are to encourage, promote and support the efforts of its 34 member states to achieve agricultural development and rural well-being. The 1998–2002 policy document that sets IICA's priorities, focusses on an integrated approach to agricultural development based on sustainability, equity and competitiveness. The Institute's actions aim to contribute to human development in rural areas, foster sustainable agriculture and recognition of the need for new approaches, and promote the involvement of the private sector in agricultural decisions. DFAIT provides funding to IICA and works closely with AAFC in the management of Canada's involvement. IICA has 34 member states.	DFAIT
Intergovernmental Panel on Climate Change (IPCC)	The role of the IPCC is to assess the scientific, technical and socio-economic information relevant for understanding the risk of human-induced climate change. It does not carry out new research, nor does it monitor climate-related data. It bases its assessment mainly on published and peer-reviewed scientific technical literature.	DFAIT EC

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ANNEX C — PART II

Inventory of Canada's Federal Participation and Investment in International S&T*

Part II: Participation in Major International Organizations, Conventions and Treaties with an Undetermined S&T Component

Organization Name	Description of Organization	Contributing Department or Agency
Section B: Other international organizations		
International Energy Agency (IEA)	*The IEA is an autonomous agency linked with the OECD. See page 6 for information on the OECD.* The objectives of the IEA include the following: 1) to maintain and improve systems for coping with oil supply disruptions; 2) to promote rational energy policies in a global context ; 3) to operate a permanent information system on the international oil market; 4) to improve the world's energy supply and demand structure; and 5) to assist in the integration of environmental and energy policies. DFAIT provides funding to the IEA and works closely with NRCan to manage Canada's involvement in the organization and the Forest Energy Agreement. Canada is one of 25 member states in the IEA.	DFAIT NRCan/ Energy Sector, Forestry Sector
North Atlantic Treaty Organisation (NATO)	The fundamental role of NATO is to safeguard the freedom and security of its member countries. Its first task is to deter and defend against any threat of aggression against any members. There are 19 member countries in the NATO alliance. National Defence supports the following three activities: – The NATO Research and Technology Organization (RTO), responsible for integrating the direction and coordination of NATO defence research and technology; conducting and promoting cooperative research and technical information exchange among national defence research activities; developing a long-term NATO research and technology strategy; and providing advice on research and technology issues. – The NATO Consultation, Command and Control (C3) Agency, responsible for the acquisition functions of NATO's Communication and Information Systems. – The task of the SACLANT Undersea Research Centre (SACLANTCEN), responsible for providing scientific and technical advice and assistance to SACLANTCEN in the field of anti-submarine warfare and mine countermeasures. The Centre carries out research and limited development in these fields, including oceanography, operational research and analysis, advisory and consultancy work, and exploratory research. In addition, DFAIT provides funding for the NATO Science Program which offers support for international collaboration between scientists from countries of the Euro-Atlantic Partnership Council (EAPC) and scientists of Mediterranean Dialogue countries. The support for collaboration is channelled through a range of different mechanisms or activities designed both to create enduring links between researchers in different countries and to stimulate the cooperation that is essential to progress in science, with the objective of contributing to overall stability and peace.	DND DFAIT
Nuclear Energy Agency (NEA)	*The NEA is a semi-autonomous body within the OECD, See page 6 for information on the OECD.* The objective of the NEA is to contribute to the development of nuclear energy as a safe, environmentally acceptable and economical energy source through cooperation among its participating countries. The NEA membership currently consists of 27 countries across Europe, America and Australasia. It represents 85% of the world's installed nuclear capacity and includes a large majority of the countries that are more advanced in the nuclear field.	DFAIT
Organization of American States	Through the Summit of the Americas process, the OAS has been given important responsibilities and mandates, including: 1) strengthening freedom of speech and thought as a basic human right; 2) promoting greater participation by civil society in decision making at all levels of government; 3) improving cooperation to	DFAIT

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ANNEX C — PART II

Inventory of Canada's Federal Participation and Investment in International S&T*

Part II: Participation in Major International Organizations, Conventions and Treaties with an Undetermined S&T Component

Organization Name	Description of Organization	Contributing Department or Agency
Section B: Other international organizations		
(OAS)	address the problem of illegal drugs; and 4) supporting the process to create a Free Trade Area of the Americas. The Office of Science and Technology at the OAS has a mission to develop, foster and support activities that contribute to the advancement of science and technology in the member states, and to promote their economic, social, cultural, scientific and technological development. The OAS has 35 member states. DFAIT is the lead agency for Canada's participation in the OAS, with the support of SBDAs and other parties, as appropriate.	
Organisation for Economic Co-operation and Development (OECD)	The OECD provides a setting for governments to discuss, develop and perfect economic and social policy. Governments compare experiences, seek answers to common problems and work to coordinate domestic and international policies that increasingly, in today's globalized world, must form a web of even practice across nations. In addition to the International Energy Agency and the Nuclear Energy Agency *(see previous page)*, the OECD has a number of directorates engaged in S&T. The most important of these is the Directorate on Science, Technology and Industry and its Committee on Scientific and Technological Policy (CSTP). Canada is currently active in the following sub-committees: – Innovation and Technological Policy – Networks of Experts on S&T Indicators (NESTI) – Global Science Forum (to which Industry Canada contributes) – Working Party on Biotechnology. DFAIT is the overall lead department for Canada's involvement in the OECD. In cooperation with DFAIT, Industry Canada is the lead department for Canada's representation in the CSTP. SBDAs are invited to support DFAIT and to contribute as appropriate to the work of CSTP sub-committees, depending on their sectoral interest. The OECD has 29 member countries.	DFAIT IC
Pan American Health Organization (PAHO)	PAHO is an international public health agency working to improve health and living standards in the countries of the Americas. Health Canada covers the cost of Canada's membership in PAHO plus a contribution to undertake research and program activities to help reduce the use of tobacco products. PAHO member states include all 35 countries of the Americas.	HC

ANNEX C — PART II

Inventory of Canada's Federal Participation and Investment in International S&T*

Part II: Participation in Major International Organizations, Conventions and Treaties with an Undetermined S&T Component

Program/Project Name	**Program Description**	**Contributing Department or Agency**
Section C: Conventions and treaties		
Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO)	The Comprehensive Nuclear-Test-Ban Treaty (CTBT) prohibits any nuclear weapon test explosion or any other nuclear explosion anywhere in the world. The Treaty provides for a global verification regime, including an International Monitoring System (IMS) comprising 321 monitoring stations worldwide, a communications system, an international data centre, and on-site inspections to monitor compliance. The Preparatory Commission for the CTBTO in Vienna is responsible for setting up the global verification regime. The network of monitoring stations will be capable of registering vibrations from a possible nuclear explosion underground, in the seas and in the air, as well as detecting radioactive debris released into the atmosphere. The stations will transmit the data via satellite to the International Data Centre (IDC) within the Preparatory Commission in Vienna, where the data will be used to detect, locate and characterize events. The IMS data and IDC products will be made available to the signatory states for final analysis. The Treaty has been signed by 155 states.	DFAIT
Convention on Biological Diversity (CBD)	*This is a program of the UNEP. See Section A for information on the UNEP.* The objectives of the Convention on Biological Diversity are "the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources." DFAIT's contribution includes Canada's contribution for the Permanent Secretariat of the CBD in Montréal and the Canadian assessed and voluntary contributions to the budget of the Biodiversity Convention Secretariat. The UN Convention on Biological Diversity has approximately 168 signatories.	DFAIT
Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (Basel Convention)	*This is a program of the UNEP. See Section A for information on the UNEP.* The Convention seeks to control the transboundary movement of hazardous wastes and hazardous recyclable materials, and promote their environmentally sound management.	DFAIT
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	*This is a program of the UNEP. See Section A for information on the UNEP.* CITES seeks to control the trade in species of wild animals and plants which are, or may be, threatened with extinction as a result of international trade. For the purposes of the Convention, "international trade" includes the international movement of plant and animal species. The Convention applies to both live and dead specimens, as well as their parts and derivatives. Currently CITES lists more than 30 000 species of animals and plants. CITES is currently composed of 151 member nations that ban, regulate and monitor international trade in endangered wild species.	EC

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ANNEX C — PART II

Inventory of Canada's Federal Participation and Investment in International S&T*

Part II: Participation in Major International Organizations, Conventions and Treaties with an Undetermined S&T Component

Program/Project Name	**Program Description**	**Contributing Department or Agency**
Section C: Conventions and treaties		
Convention on Wetlands of International Importance Especially as Waterfowl Habitat (Ramsar Convention)	*This is a program of the UNEP. See Section A for information on the UNEP.* The official name of the Ramsar Convention reflects its original emphasis on the conservation and wise use of wetlands primarily to provide habitat for waterfowl. Over the years, however, the Convention has broadened its scope to cover all aspects of wetland conservation and wise use, recognizing wetlands as ecosystems that are extremely important for the conservation of biodiversity in general and for the well-being of human communities.	EC
International Program on Chemical Safety (IPCS)	The IPCS is a joint activity of three cooperating international organizations: namely the UNEP, the International Labour Office (ILO) and the World Health Organization (WHO). The main objective of the IPCS is to conduct and disseminate evaluations of the hazards to human health and the environment posed by chemicals.	HC
Montreal Protocol on Substances that Deplete the Ozone Layer	*This is a program of the United Nations Environment Programme (UNEP). See Section A for information on the UNEP.* The Montreal Protocol on Substances that Deplete the Ozone Layer is a landmark international agreement, whereby 172 countries have committed to a precise schedule for reducing and eventually phasing out their consumption and production of ozone-depleting substances. DFAIT's contribution goes toward the Trust Fund for the Montreal Protocol and EC supports the Multilateral Fund.	EC DFAIT
NAFTA Commission for Environmental Cooperation (CEC)	The CEC, an international organization created under the auspices of the North American Free Trade Agreement (NAFTA) which includes Canada, Mexico and the United States, was established to address regional environmental concerns, help prevent potential trade and environmental conflicts, and promote the effective enforcement of environmental law.	EC
UN Framework Convention on Climate Change (UNFCCC)	*This is a program of the UNEP. See Section A for information on the UNEP.* The UNFCCC is rooted in the Kyoto Protocol, which was adopted by consensus in December 1997. It commits developed countries to reduce their collective emissions of six key greenhouse gases by at least 5% by the period 2008–12. Article 2 of the UNFCCC states that "The ultimate objective...[is to] stabilize greenhouse gas concentrations at levels that would prevent dangerous anthropogenic interference with the climate system. Such levels would be achieved within a time frame to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened, and to enable economic development to proceed in a sustainable manner." One of the six programs at the UNFCCC is the Science and Technology (S&T) program. S&T deals with the methodological, scientific and technological aspects of the Convention process. Its activities include developing methodologies to improve data accuracy, identifying options to promote the transfer of climate-friendly technologies and elaborating methodologies and tools for evaluating adaptation strategies. An important element of S&T's current work program concerns the technical aspects of the Protocol, for example, the drafting of reporting guidelines and issues relating to carbon sinks. In total, 84 parties (including the European Community) have signed the UNFCCC which is a legally binding agreement.	DFAIT EC

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ANNEX C — PART II

Inventory of Canada's Federal Participation and Investment in International S&T*

Part II: Participation in Major International Organizations, Conventions and Treaties with an Undetermined S&T Component

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ANNEX D

Canada's Central Sources of Funding for International S&T Projects and International Researcher Exchanges in S&T

Part I identifies the federal programs that are open to the S&T commmunity at large, i.e., those that are not restricted to employees of a specific organization.

Part II identifies the provincial programs that are open to the S&T community at large but restricted to the residents of the provinces that are funding the programs.

ANNEX D — PART I

Canada's Central Sources of Funding for International S&T Projects and International Researcher Exchanges in S&T

Part I: Federal Government*

Agency	Name of Program	Objectives	Level of Funding	Total Fund	Internet address
Natural Sciences and Engineering Research Council of Canada (NSERC)	International Opportunity Fund (established in 1998)	To support Canadian participation in workshops and symposiums that will lead to collaborative research projects and programs	In accordance with eligible expenses	$1.5M/year (supports approx. 60 projects/year)	**http://www.nserc.ca/intern/iof.htm**
	Collaborative Research Opportunities Program (established in 1998)	To facilitate Canadian participation in large-scale national and international research projects	Major projects requiring in excess of $100K/year/project	$2M/year (supports approx. 15 projects/year, a number of which are of an international nature); expected to grow to $6M by 2002–03	**http://www.nserc.ca/programs/resguide/cro_e.htm**
	Postgraduate scholarships	To support high-calibre Canadian scholars who are engaged in master's or doctoral programs for up to four years	$17–19K/year; 3361 scholarships in 1998–99; about 100 scholarships/year for studying abroad	Less than $2M for the support of scholars overseas ($53M for the program)	**http://www.nserc..ca/**
	Postdoctoral fellowships	To support Canadian talented science and engineering researchers for up to two years	$35K/year for two years; 485 scholarships in 1998–99; 65% of the fellowships are being spent abroad	Approx. $8M for the support of postdoctoral fellows overseas ($13M for the program)	**http://www.nserc..ca/**
	Visiting Fellowships in Canadian Government Laboratories • Funded by the Canadian government laboratories, administered by NSERC	To provide young scientists and engineers with an opportunity to work with groups of researchers or leaders in Canadian government laboratories and research institutions	$37K/year Duration: one year, renewable for up to two more years Up to one third of the fellowships are allocated to foreign recipients	66 fellowships awarded to foreign recipients (out of a total of 146) in 1999–2000	**http://www.nserc..ca/**

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* The list identifies the federal programs that **explicitly** target the support of international S&T projects or international researcher exchanges in S&T, or that could be accessed for the support of those activities, and that are open to the S&T community at large (e.g. not restricted to the employees of a specific organization). The organizations are listed according to the total level of funding they provide.

ANNEX D — PART I

Canada's Central Sources of Funding for International S&T Projects and International Researcher Exchanges in S&T

Part I: Federal Government*

Agency	Name of Program	Objectives	Level of Funding	Total Fund	Internet address
Natural Sciences and Engineering Research Council of Canada (NSERC) *(cont'd)*	NATO Science Fellowships Program • Funded by NATO, administered by NSERC	To offer opportunities for emerging scientists and Engineers from Central and Eastern European NATO partner countries to pursue postdoctoral research in the natural sciences and engineering at Canadian universities	$33K/year for up to two years	10 fellowships awarded in 1999–2000	**http://www.nserc..ca/**
National Research Council Canada (NRC)	Technology Inflow Program (TIP) through the NRC Industrial Research Assistance Program (IRAP)	To provide support to SMEs in assessing new technological developments abroad	Support for specific TIP projects will not normally exceed $10K	$700K; 160 projects supported in 1999–2000	**http://www.nrc.ca/corporate/english/index.html**
	Research Associates Program	To support research associates who have acquired a Ph.D. in natural sciences or engineering or a master's degree in engineering within the past five years	Minimum of approx. $37K Duration: two-year term, renewable to a maximum of five years The program is accessible to foreigners, under certain conditions	There are currently 23 foreign research associates out of a total of 154	**http://www.nrc.careers**

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* The list identifies the federal programs that **explicitly** target the support of international S&T projects or international researcher exchanges in S&T, or that could be accessed for the support of those activities, and that are open to the S&T community at large (e.g. not restricted to the employees of a specific organization). The organizations are listed according to the total level of funding they provide.

ANNEX D — PART I

Canada's Central Sources of Funding for International S&T Projects and International Researcher Exchanges in S&T

Part I: Federal Government*

Agency	Name of Program	Objectives	Level of Funding	Total Fund	Internet address
Department of Foreign Affairs and International Trade (DFAIT)	Going Global S&T Program (in the process of being renewed)	To assist Canadians in the identification and establishment of new collaborative R&D initiatives Emphasis will be on supporting projects that build on Canada's S&T and foreign policy priorities, facilitate the access of Canadian researchers to major international networks, and ensure that Canadian companies can gain access to cutting-edge research and technologies that are not available in Canada. In particular, the program supports projects that aim to establish coordination mechanisms/platforms for exploring international R&D collaborative opportunities with major foreign partners or international programs.	The program contributes, on a non-refundable basis, up to 50% of non-research activities associated with the establishment of collaborative projects (travel costs, short-term coordination costs and so on). The program contributes up to a maximum of $50K per project.	$390K for 2000–01	Currently being developed

Additional information:

1. The Social Sciences and Humanities Research Council of Canada (SSHRC) is currently exploring the possibility of creating a fund for supporting Canadian participation in international projects in social sciences and humanities.
2. The Canadian Institutes for Health Research (CIHR), which replaces the Medical Research Council of Canada, is in the process of being established. It is not yet known if CIHR intends to establish a fund for Canadian participation in international projects in the health domain.
3. Human Resources Development Canada (HDRC) has a number of programs, e.g., Program for North American Mobility (which includes Canada, Mexico and the United States) and the Canada-European Community Program for Higher Education which are student-centered, rather than research-centered. As a result, they are not included in the list.

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* The list identifies the federal programs that **explicitly** target the support of international S&T projects or international researcher exchanges in S&T, or that could be accessed for the support of those activities, and that are open to the S&T community at large (e.g. not restricted to the employees of a specific organization). The organizations are listed according to the total level of funding they provide.

ANNEX D — PART II

Canada's Central Sources of Funding for International S&T Projects and International Researcher Exchanges in S&T

Part II: Provincial Government*

Province	Ministry/ Agency	Name of Program	Objectives	Level of Funding	Total Fund	Internet address
Quebec	Ministry of Research, Science and Technology	Financial assistance for scientific and technological cooperation	To facilitate the participation of Quebec enterprises and researchers in international research cooperation programs, international research consortia, and research and demonstrations projects arising from international bilateral cooperation between Quebec and various countries	Maximum: $200K/project	$2M/year; expected to increase up to $5M/year	**http://www.mrst.gouv.qc.ca**
	Ministry of Education	Merit Fellowships for postdoctoral research	To support researchers who have acquired a Ph.D. within the past three years or are about to obtain their degree, and who come from priority countries	Travel expenses and a monthly allowance of $2K/month for 12 months	30 fellowships in 2000–01 Budget: approx. $600K/year	**http://www.meq.gouv.qc.ca/m_ped.htm**
		Merit Fellowships for graduate or postgraduate studies	To support, in particular, foreign gifted students (coming from priority countries) for graduate or postgraduate studies in Quebec	$28K/year for a graduate fellowship duration: six academic sessions More than $39K for a postgraduate fellowship Duration: 12 academic sessions	35 fellowships in 2000–01 Budget: approx. $400K/year	**http://www.meq.gouv.qc.ca/m_ped.htm**
		Merit Fellowships for study or scientific research visits	To support visits from foreign professors, administrators and researchers to Quebec	Travel and monthly allowance Duration: 4 to 12 weeks	Budget: approx. $200K/year	**http://www.meq.gouv.qc.ca/m_ped.htm**
		Quebec–France S&T cooperation	To facilitate the exchanges of university professors	Travel costs and a stipend to Quebec professors for visits up to four weeks at the invitation of a French university	Budget: approx. $200K/year	**http://www.meq.gouv.qc.ca/m_ped.htm**
		Postgraduate scholarships	To allow foreign postgraduate students to study in Quebec, and Quebec postgraduate students to study in countries or regional entities with which Quebec has signed agreements, e.g., China, Germany, Bavaria and Francophone Belgium	Financial support to Quebec residents varies from one agreement to another	Budget: approx. $200K/year	**http://www.meq.gouv.qc.ca/m_ped.htm**

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* The list identifies the provincial programs that **explicitly** target the support of international S&T projects or international researcher exchanges in S&T, or that could be accessed for the support of those activities, and that are open to the S&T community at large but restricted to the residents of the provinces that are funding the programs. The provinces are listed according to the total level of funding they provide.

ANNEX D — PART II

Canada's Central Sources of Funding for International S&T Projects and International Researcher Exchanges in S&T

Part II: Provincial Government*

Province	Ministry/ Agency	Name of Program	Objectives	Level of Funding	Total Fund	Internet address
Quebec	Ministry of Education	Postdoctoral fellowships	To support researchers who have acquired a Ph.D. Eligibility is in accordance with the agreements signed between Quebec and other countries or regional entities (e.g. Quebec–Catalogne and, more recently, Quebec–Mexico)	Fellowships of 12 months	$50K/year	**http://www.meq.gouv.qc.ca/m_ped.htm**
	Fonds de la recherche en santé du Québec (FRSQ)	Programme de soutien àla tenue d'événements scientifiques à caractère international	To promote the vitality of health research in Quebec by providing funding for international events in Quebec	Maximum of $10K	Not available	**http://www.frsq.gouv.qc.ca/Prospectus/2001-2002/Autres/Soutien.htm**
	In addition: 1. Each year, some 2000 foreign postgraduate students are exempted from tuition fees, at a cost of close to $100M/year. 2. The Ministry of Education recently announced the establishment of a $10M fund to support Quebec students who wish to pursue their studies abroad.					
Ontario	Energy, Science and Technology	MOU with the Singapore National S&T Board - Signed in 1994 and extended for an additional four years	To support collaborative projects in the areas of environmental and resource management technologies, biotechnology, information and communications technologies, manufacturing and materials technologies	Assistance to companies according to eligible expenses Proceeds by calls for proposals; five projects are supported under the 1999–2001 round of the agreement	$800K/year	**http://www.est.gov.on.ca/english/st/st_istra.html**
		MOU with the State of Baden Wurttemberg in Germany; in effect for more than a decade	To support collaborative projects in various areas, with a recent focus on digital media			
Newfoundland and Labrador	Industry, Trade and Technology	MOU with the Republic of Ireland	To encourage cooperation in a broad range of areas, including research and development, and technology transfer	Assistance to companies	$100K/year	

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Canada's Central Sources of Funding for International S&T Projects and International Researcher Exchanges in S&T

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Province	**Ministry/ Agency**	**Name of Program**	**Objectives**	**Level of Funding**	**Total Fund**	**Internet address**
British Columbia	B.C. Advanced Systems Institute	Visiting Fellowship Program	To provide support to experts invited to B.C. universities Eligible fields: robotics, computer science, micro-electronics and telecommunications	Maximum of $7.5K for stays from two weeks to one year	$30K/year	**http://www.asi.bc.ca/asi/programs/funding/vff**

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ANNEX E

Central Sources of Funding for International S&T Projects and International Researcher Exchanges in S&T In Selected Countries: Some Examples

Countries included:

- Australia
- France
- Germany
- Japan
- Netherlands
- United Kingdom
- United States

ANNEX E

Central Sources of Funding for International S&T Projects and International Researcher Exchanges in S&T In Selected Countries: Some Examples*

Country	General Comments	Base Department for S&T Counsellors	Brief description of activities supported and level of funding
Australia Currency: Australian dollar (A$) Approximate exchange rate: C$1 = A$1.2 or A$1 = C$0.80	There is a strong international culture in the Australian academic and research communities. International collaboration forms both an implicit and an explicit part of the policy framework for Australia's S&T.	Industry, Science and Resources	***Ministry of Industry, Science and Resources*** • The Technology Diffusion Program has two components: Technology Alliances and Technology Transfer, with a budget of A$90M for the period 1998–2002. *Note: There is no separate budget indication for each component of the Technology Diffusion Program. However, the budget for the program component now replaced by Technology Alliances was A$5.6M in 1997–98.* Technology Alliances has five components: - Industrial Research Alliances facilitates international industrial research collaborators and international technology diffusion workshops held in Australia. - Targeted Research Alliances provides support for non-research costs (e.g. travel and living expenses) associated with international networking activities and international showcasing of Australian S&T capabilities. The networking activities supported include collaborative research, workshops and scientific missions. - International Science and Technology Networks facilitates the establishment of international S&T networks through international exchange, fellowship and award programs, and targeted missions with priority countries. - The International Conference Support Scheme promotes the organization of major international conferences in Australia and the participation of overseas persons or organizations able to contribute knowledge and information of benefit to Australia. - The Major Research Facility supports Australian access to major international research facilities not available in Australia. ***Ministry of Education, Training and Youth Affairs*** • International Researcher Exchange Program (A$2.6M) Provides funding to support the movement of researchers to and from Australia, enabling collaboration between researchers in research institutions and centres of excellence. • International Postgraduate Research Scholarships (A$16.2M) Supports high-calibre overseas postgraduate students in areas of research strength in institutions of higher education.

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Country	General Comments	Base Department for S&T Counsellors	Brief description of activities supported and level of funding
France Currency: French franc (FF) Approximate exchange rate: C$1 = FF4.7 or 1 FF = C$0.21 Also: C$1 = 0.72 euro	Large, publicly funded research organizations, e.g., the CNRS, INRA, INSERM, INRIA, IFREMER *(see below for definition of acronyms)*, determine and finance their own international activities. They usually have an Office of International Relations, which manages international activities. CNRS: Centre national de la recherche scientifique INRA: Institut national de la recherche agronomique INSERM: Institut national de la santé et de la recherche médicale INRIA: Institut national de recherche en informatique et en automatique IFREMER: Institut français de recherche pour l'exploitation de la mer	Foreign Affairs	***Ministry of Foreign Affairs*** 1. Programs of the *Direction générale de la coopération internationale et du développement* (DGCID) Total budget: approximately 1.5M euros, 2/3 of which are spent on international development. The DGCID programs (open to all sectors, including S&T) are the following: • *Programmes d'actions intégrées* — Funds the incremental costs of international bilateral research projects (budget: FF13M for 2000). • *Bourses Lavoisier* — Allows young French researchers to spend one year in a foreign organization (budget: FF23.6M for 2000). • *Bourses du gouvernement français* — 23K per year (budget: FF555M) — Specifically designed for foreigners wishing to study or pursue research in France; 1.3% of the scholarships have been allocated to North Americans. 2. Programs of the *Direction de la coopération scientifique universitaire et de recherche* • *Programmes de recherche bilatéraux* — Supports bilateral S&T projects with some 20 "targeted" countries (duration: two to three years; funding: from FF20K to FF400K per project). • *Bourses et aides à la mobilité internationale* — Supports French researchers going overseas as well foreign researchers coming to France. For example, under this program, foreign senior scientists can spend up to one year in a French research organization. ***Ministry of Education, Research and Technology*** *(Note: In April 2000, the Ministry was divided into the Ministry of National Education and the Ministry of Research)* • Programs to facilitate exchanges of researchers: - FF5M for visiting senior researchers (80 per year, one- to six-month visits, selection process involves calls for proposals) - Visiting associate professors for a total of one year over a maximum three-year period (60 per year) - FF35M for visiting postdoctoral fellows in 2000 (250 to be accepted).

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Country	General Comments	Base Department for S&T Counsellors	Brief description of activities supported and level of funding
Germany Currency: Deutsche mark (DM) Approximate exchange rate: C$1 = DM1.4 or DM1 = C$0.7	Since Germany is a federal state, the responsibility for scientific research and its exploitation is jointly shared by the two levels of government: federal and *lander* (provincial). The Federal Ministry for Education and Research (BMBF) is the main government body for the coordination and development of national policies and programs. It also has the lead in the management of international S&T cooperation programs.	Foreign Affairs	***Federal Ministry for Education and Research (BMBF)*** BMBF spends approximately DM25M for funding "mobility," e.g., individual expert visits, scoping/exploratory missions, workshops and so on for promoting international cooperation. It comprises two branches: the first for the European Union and the second for other countries (including Canada). The branches comprise 13 separate directorates (with a total staff of 99). In addition, BMBF's work is facilitated by an International Bureau (with a staff of 31 and a budget of DM13.7M), which ensures the operation of projects under specific bilateral S&T agreements. ***Ministry of Foreign Affairs (AA)*** The Ministry's budget for international exchanges/programs is DM215.72M for 2000. This budget includes funding for the German Academic Exchange Service and the Humboldt Foundation. It also includes a special fund of approximately DM10M to support expert visits and missions conducted under bilateral S&T agreements. ***German Academic Exchange Service (DAAD)*** DAAD is a private, publicly funded, self-governing organization of higher education and student bodies in the Federal Republic of Germany. It operates mainly on the basis of public funding provided by different ministries, primarily by the Federal Ministry of Foreign Affairs. Its total budget is DM422M. DAAD sponsors undergraduates, postgraduates and academics from Germany and abroad in more than 100 different programs. The programs cover, for example, one-year and short–term scholarships for individuals, group programs (study visits, university seminars, conferences and so on), the exchange of academics, and project-linked academic cooperation between institutions of higher education. The DAAD budget for bringing researchers to Germany is DM110M, and for supporting Germans abroad is DM38M.

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Central Sources of Funding for International S&T Projects and International Researcher Exchanges in S&T In Selected Countries: Some Examples*

Country	**General Comments**	**Base Department for S&T Counsellors**	**Brief description of activities supported and level of funding**
Germany *(cont'd)* Currency: Deutsche mark (DM) Approximate exchange rate: C$1 = DM1.4 or DM1 = C$0.7		Foreign Affairs	***Humboldt Foundation*** The Foundation is a non-profit organization under private law established by the Federal Republic of Germany. It is predominantly publicly funded (mainly by the Ministry of Foreign Affairs) and has a budget of DM83M. Its programs are described below. • Research Fellowships for Non-German Scholars: Includes the Humboldt Research Fellowships (up to 500 annually) for foreign scholars holding a doctorate (or equivalent), and the Georg Forster Fellowships (up to 25 annually) for scholars from developing countries (excluding India and the People's Republic of China). • Research Fellowships for German Scholars holding a doctorate, i.e., Feodor Lynen Research Fellowships, (up to 150 annually). • Research Awards for non-German scholars: - Humboldt Research Awards to internationally recognized foreign scholars (4- to 12-month duration, from DM20K to DM150K, up to 150 annually); - Max Planck Research Awards for international cooperation between German and non-German scholars (up to DM250K and up to 12 annually). *Note: In addition,, the 16 lander (provincial governments) cover the costs of tuition for foreign scholarship holders admitted to German organizations of higher education.*

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Country	General Comments	Base Department for S&T Counsellors	Brief description of activities supported and level of funding
Japan Currency: yen (¥) Approximate exchange rate: C$1 = ¥72.7 or ¥100 = C$1.4	The S&T Basic Law, enacted in 1995, provides the framework for future S&T policies in Japan. The law specifically refers to the importance of the promotion of international S&T cooperation. In 1999–2000, out of a total budget of ¥3.2 trillion, ¥117B were earmarked to promote international cooperation. There is no maximum set for the funding of international projects. The number of projects supported in the various categories depends on the annual budgetary allocation of the Ministry of Finance (MOF). Budget requests to the MOF from each ministry/agency are the result of an extensive internal consultation process.	Foreign Affairs — Division of Economic Affairs	***Counc'l for Science & Technology (CST), Prime Minister's Office*** — through Science & Technology Agency (STA) • Special coordinating funds for promoting S&T (¥1.8B in 1999) are as follows: 1. Promotion of international research exchange Supports researcher exchanges (60 in 1999) and workshops (40 in 1999, average support: ¥7M – ¥8M per workshop). 2. International research cooperation (50 projects in 1999, average support: ¥25M per project). ***Science & Technology Agency*** – through Japan Science & Technology Corporation (JST) • STA Fellowship Program (¥3.8B in FY1999, 418 fellows accepted) Provides research opportunities in Japan's national research institutes for young researchers from overseas. *Note: The number of fellows varies each year depending on Japan's budgetary situation.* • International Cooperative Research Project (ICORP) (¥2.0B in FY1999) Supports cooperation that will lead to innovative knowledge and create new concepts between Japanese and foreign researchers through a cost- and resource-sharing scheme (two projects/year, five-year duration). • Cooperative Research Fellowship (¥0.36B in FY1999) Supports Japanese researchers from national institutes, public corporations and non-profit organizations in various Asia–Pacific countries, in Russia and in Eastern European countries (duration: one to three years). • Overseas Research Fellowship (¥0.172B in FY1999) Sends postdoctoral fellows and young researchers to leading institutes abroad for one to two years.

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Country	General Comments	Base Department for S&T Counsellors	Brief description of activities supported and level of funding
Japan *(cont'd)* Currency: yen (¥) Approximate exchange rate: C$1 = ¥72.7 or ¥100 = C$1.4	Starting in 2000–01, as the reform proceeds, substantial changes are expected to take place, thus affecting many projects that have been ongoing. In particular, it is expected that the changes in the status of the national research institutes that are to become independent agencies will have an impact on those programs.	Foreign Affairs — Division of Economic Affairs	***Monbusho*** — through the Japan Society for the Promotion of Science (JSPS) • Invitation Fellowship Program for Research in Japan (¥1.1B in FY2000–01, 745 fellows accepted) Supports Japanese researchers to allow them to invite foreign colleagues to participate in cooperative work in Japan. • Postdoctoral Fellowship for Foreign Researchers (¥3.9B in FY2000–01) Supports promising foreign researchers to provide them with an opportunity to conduct cooperative research in Japan. • Postdoctoral Fellowship for Research Abroad (¥1.2B in FY2000–01) Supports funding of young Japanese postdoctoral fellows to conduct research abroad for two years. • Cooperative Programs with Asian Countries (¥1.3B in FY2000–01) Includes university exchange programs, scientist exchange programs, and Asian science seminars. **Ministry of Industrial Trade and Industry (MITI)** — through the Agency of Industrial Science and Technology Agency (AIST) Note: The New Energy and Industrial Technology Development Organization (NEDO) implements most of the programs that the AIST develops. • International Researchers Exchange Program (AIST Fellowship — ¥0.4B in FY1999, 31 fellows accepted) Supports foreign researchers to work in 15 AIST institutes across Japan. • ITIT Projects (¥0.365B in FY1999, for a total of 33 projects conducted) Supports joint research with developing countries, focussing on mining/industrial technologies as required by the countries. *Note: 30 projects were conducted in FY1998. The number of projects varies each year.*

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Japan *(cont'd)* Currency: yen (¥) Approximate exchange rate: C$1 = ¥72.7 or ¥100 = C$1.4		Foreign Affairs — Division of Economic Affairs	***Ministry of Industrial Trade and Industry (MITI)*** — through the Agency of Industrial Science and Technology Agency (AIST) *(cont'd)* • International Joint Research Grant Program (¥1.0B yen, ¥20M to ¥30M/project, up to three years) Supports international joint research projects in the areas of energy, global environment and international standards • International Joint Research Program (¥5.2B, 19 projects supported in 1998–99) • Short-term International Joint Research on Environmental Technologies (¥0.1B in FY1999) Supports Japanese researchers to stay at foreign universities and research labs for up to six months to conduct joint research. • Japan Industry and Technology Management Training Program (JITMT) (¥0.4B in FY1999) Supports university co-op programs, primarily between the United States and Canada, and Japan.

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Country	General Comments	Base Department for S&T Counsellors	Brief description of activities supported and level of funding
Netherlands Currency: Netherlands guilder (NLG) Approximate exchange rate: C$1 = NLG1.6 or NLG1 = C$0.63	The Netherlands invests nearly NLG15B in R&D annually. The primary responsibility for science policy, and thus for the state of research, lies with the Ministry of Education, Culture and Science. A part of the government research budget is controlled by various organizations. The two most important are the Netherlands Organization for Scientific Research (NWO) and the Royal Netherlands Academy of Arts and Sciences (KNAW). NWO funds research in universities and in its own institutes. KNAW funds its own researchers working within the universities or in its own institutes.	Economic Affairs	***Ministry of Economic Affairs*** The total budget in 2000 for international S&T cooperation in industrial projects is NLG32M, distributed as follows: • NLG18M are dedicated to EUREKA projects, i.e., bilateral projects between companies in two or more countries that are part of the EUREKA consortium and • NLG14M are dedicated to further bilateral international technological cooperative projects between Dutch and foreign companies from either the "emerging" markets (e.g. China and Indonesia), or a number of "developed" countries (e.g. the United States, Japan and Israel). ***Ministry of Education, Culture and Science*** • The Ministry has bilateral scientific agreements with a limited number of countries: Russia, China, Indonesia, Hungary and France. These agreements are oriented toward the performance of joint research projects. The budget of the Ministry for these activities is approximately NLG10M. ***The Royal Netherlands Academy of Arts and Sciences (KNAW)*** • KNAW awards travel grants to Dutch senior researchers for visits to scientific conferences abroad, and sponsors international scientific conferences to be organized in the Netherlands. The budget for these activities is approximately NLG1.1M/year (in 1999, 208 awards were granted).

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Country	General Comments	Base Department for S&T Counsellors	Brief description of activities supported and level of funding
Netherlands *(cont'd)* Currency: Netherlands guilder (NLG) Approximate exchange rate: C$1 = NLG1.6 or NLG1 = C$0.63		Economic Affairs	***Netherlands Organization for Scientific Research (NWO)*** • The fellowship program supports the exchange of researchers, making it possible to invite senior researchers from abroad to the Netherlands. In 1999, 79 requests were accepted. • NWO also subsidizes the visits of Dutch researchers to other countries, up to a maximum of three months. In 1999, 151 requests were accepted. • NWO had a budget for visits to conferences abroad or for short working visits of Dutch postgraduates. In 1999, 1575 requests were accepted. However, due to the budgetary situation, NWO ended this program in 2000. • NWO has a number of bilateral agreements with sister organizations abroad, with the aim of exchanging researchers. In 1999, NWO's total budget for grants was NLG9M.

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United Kingdom Currency: pound sterling (£) Approximate exchange rate: C$1 = £0.4 or £1 = C$2.5	Science and technology are decentralized in the United Kingdom, with each government department responsible for its own areas of S&T. However, coordination is ensured through the Office of Science and Technology, which sits within the Department of Trade and Industry. Most government support for international research cooperation is routed through the six Research Councils. Two of them (i.e. the Biotechnology and Biological Sciences Research Council and the Medical Research Council) have funds explicitly earmarked for promoting and supporting international cooperation. The other four support international activities through their domestic programs.	Foreign and Commonwealth Office	***British Council*** • Publicly funded to act as the United Kingdom's international organization for educational and cultural relations and to enhance the United Kingdom's reputation in the world. It does so through programs in education, English language teaching, the arts, science and governance (total annual budget of £6.7M). • Support Joint Research Programs (not all in science) with 19 countries; financial support includes fare and subsistence for exploratory and bilateral visits of specialists for approved projects of up to three years' duration. ***The Royal Society*** • Supports an extensive range of international Cupertino with more than 50 countries (£5.1M were spent in 1999–2000, £3.25M of which from the Royal Society and the rest from private sources). • Main programs include the following. - International Scientific Collaboration: Provides grants for scientific research visits to and from the United Kingdom. Fellowship grants are aimed at young scientists and provide opportunities to do research in a different country for up to two years. Joint research project grants provide funding over 24 months for exchange visits to take place in connection with a bilateral research collaboration between a U.K. and an overseas research group. - Conference grants are awarded to scientists based in the United Kingdom who are presenting their papers at an overseas conference. - Royal Society International Research Programmes: Three programs dealing with environmental issues are being funded. **The Royal Academy of Engineering** • Total budget for international activities: £1.4M, £0.7M of which from the Academy. Part of this budget includes payment of membership subscriptions to international engineering organizations. • Also supports a number of travel grants, which allow Ph.D. students to spend three months abroad, and facilitate collaborative research. *Note: The recent U.K. White Paper points to new funds for international S&T, including an expansion of the U.K. network of S&T counsellors and international technology advisers.*

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United States Currency: U.S dollar (US$) Approximate exchange rate: C$1= US$0.7 or US$1 = C$1.4	In 1998, U.S. federal R&D support reached US$67B (the total annual R&D expenditures were US$227B). In addition, the U.S. states are providing funding for R&D activities (US$244M in 1995). The United States spends considerable funds on international cooperation. According to a 1999 study reported in the *U.S. Science and Engineering Indicators —2000*, the rapid rise in international cooperation has spawned activities that now account for more than 10% of government R&D expenditures. In fiscal years 1993 to 1997, the US federal government spent on average US$62 million/year (not including joint projects with NASA and DOD) on cooperative R&D with Canada.	State Department	The 10 major U.S. departments and agencies that have R&D activities are the Department of Defense; the Department of Health and Human Services (DHHS), which includes the National Institutes of Health (NIH); the National Aeronautic and Space Administration (NASA); the Department of Energy (DOE); the National Science Foundation (NSF); the Department of Agriculture; the Department of Commerce, which includes the National Institute of Standards and Technology (NIST); the Department of Transportation; the Department of Interior, which includes the National Oceanographic and Atmospheric Administration; and the Environmental Protection Agency (EPA). These departments and agencies have programs to support American participation in joint international S&T programs or projects. In addition, a number of them (e.g. NIH) are directly funding foreign researchers for projects conducted overseas. It is also worth noting that a number of private foundations with large endowments provide funding for S&T projects that may have an international component. ***The National Science Foundation,*** through its Division of International Programs, is the major provider for non-sectoral, mostly academic, research grants in support of international cooperation. The NSF Division of International Programs (with a budget of US$25M) manages a set of programs that support the following: • the initial three years of cooperative research projects planned and carried out in partnership with foreign colleagues; • medium-term visits of three to six months' duration and long-term visits of 6 to 24 months' duration for individual research projects planned in cooperation with a foreign host institution (currently available for Japan only); • in a supplementary way, existing grants from other parts of NSF, in order to include junior and postdoctoral investigators, graduate students,and qualified undergraduates in the overseas phases of research and education projects; • joint seminars and workshops aimed at identifying common priorities in areas of special interest and, ideally, to begin preparation of collaborative proposals in well-defined research and education areas; and • planning visits of up to two weeks' duration to enable investigators to consult with prospective foreign partners. *Note: The NSF has just completed a review of its international S&T activities and is expected to have a strategy in place by early fall 2000.*

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Central Sources of Funding for International S&T Projects and International Researcher Exchanges in S&T In Selected Countries: Some Examples*

Country	General Comments	Base Department for S&T Counsellors	Brief description of activities supported and level of funding
United States *(cont'd)* Currency: U.S. dollar (US$) Approximate exchange rate: C$1 = US$0.7 or US$1 = C$1.4		State Department	***The Fulbright Program***, funded primarily by the U.S. State Department (more than US$105M in 2000–01), provides grants for university teaching; advanced research; graduate study; and teaching in elementary and secondary schools. The Program is open to all sectors. It operates in 140 countries, including 51 countries with binational Fulbright Commissions and Foundations. A number of private, cooperating organizations also assist with the administration of the Program. The Program has two main components: • a U.S. Student Program, which allows Americans to study or conduct research in more than 100 nations (The U.S. graduate student program is coordinated by the Institute for International Education) and • a Foreign Student Program, which allows foreign students to study or conduct research in the United States. Close to 5000 Fulbright grants are awarded each year. Nearly 200 000 Fulbright Alumni can be found in more than 140 countries throughout the world. Fulbright Alumni include Nobel and Pulitzer Prize winners, governors and senators, ambassadors and artists, prime ministers and heads of state, professors and scientists, Supreme Court Justices, and CEOs.

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[*] This table, which is not meant to be exhaustive, provides examples of central sources of funding available in selected countries and of the diversity of channels used by those countries for centrally supporting international S&T projects and exchanges of researchers in S&T (*note that some of the central sources of funding are open to all research disciplines, including S&T*). Central support for national participation in international S&T programs, facilities and organizations, as well as support for researchers by individual sectoral agencies, are not included in the table.

ANNEX F

List of Acronyms and Abbreviations

AAFC	Agriculture and Agri-Food Canada
ACST	Prime Minister's Advisory Council on Science and Technology
CANDU	Canada Deuterium Uranium (reactor)
CFI	Canada Foundation for Innovation
CIDA	Canadian International Development Agency
CIHR	Canadian Institutes for Health Research (replacing the Medical Research Council of Canada)
CSA	Canadian Space Agency
DFAIT	Department of Foreign Affairs and International Trade
DFO	Fisheries and Oceans Canada
DND	Department of National Defence
EC	Environment Canada
G7	Group of Seven (the seven most industrialized countries)
HC	Health Canada
IC	Industry Canada
ICSU	International Council for Science (formerly, International Council for Scientific Unions)
IDRC	International Development Research Centre
IRAP	Industrial Research Assistance Program (a Program of the National Research Council Canada)
MOU	Memorandum of Understanding
MRC	Medical Research Council of Canada (recently replaced by the Canadian Institutes for Health Research)
NABST	National Advisory Board on Science and Technology
NCEs	Networks of Centres of Excellence
NRCan	Natural Resources Canada
NRC	National Research Council Canada
NSERC	Natural Sciences and Engineering Research Council of Canada
OECD	Organisation for Economic Co-operation and Development
R&D	Research and development
S&T	Science and technology
SBDAs	Science-based departments and agencies
SMEs	Small- and medium-sized enterprises
SR&ED	Scientific Research and Experimental Development (Tax Incentive Program)
STCs	Science and technology counsellors
STH	Science, technology and health
TDOs	Technology development officers
TRIUMF	Tri-University Meson Facility
UNESCO	United Nations Educational, Scientific and Cultural Organization
WTO	World Trade Organization